Vol. XXI, Part IV December, 1951

The
Indian Journal of Veterinary Science
and
Animal Husbandry

5992
21.4.52

Issued under the authority
of
The Indian Council of Agricultural Research

111

5992.

सत्यमेव जयते

Annual subscription
Rs. 6 or 9s. 6d.

Price per part
Rs. 2 or 3s.

PUBLISHED BY THE MANAGER OF PUBLICATIONS, DELHI
PRINTED BY THE GOVERNMENT OF INDIA PRESS, CALCUTTA, INDIA,
1952.

ICAR. 6. XXI. 4
850.

CONTENTS

Vol. XXI, Part IV

(December, 1951)

The Publications Commitee of the Indian Council of Agricultural Research, India, takes no responsibility for the opinions expressed in this Journal

Original articles

		Page
Tests of Some Proprietory Insecticides	*P. Balarama Menon, C. M. Sen Gupta and B. C. Basu*	215
Value of a Mixture of Derris Root Powder and DDT in the Control of Poultry Lice	*P. Balarama Menon, C. M. Sen Gupta and B. C. Basu*	229
Investigations on Trace Element (Copper). I. The Distribution of Copper in Biological Materials	*K. Sahai and N. D. Kehar*	235
Some Observations on the Regional and Seasonal Incidence of Bovine Contagious Pleuro-pneumonia in Assam	*V. R. Gopalakrishnan*	245
Frequency of Occurrence of Different Strains of Foot-and-mouth Disease Virus in India (with one text-figure)	*C. Seetharaman and N. S. Datt*	251
Comparison of First and Second Ejaculates collected in Rapid Succession from the Indian Water Buffalo, *Bos bubalis*	*S. S. Prabhu and P. Bhattacharya*	257
Abstracts		263
Reviews		268

636.095405
Jm2.21

JAMMU & KASHMIR UNIVERSITY
LIBRARY
No. 5992
Date 2-10-52
SRINAGAR

ERRATA

Indian Journal of Veterinary Science and Animal Husbandry, Vol. XX, Part I. March 1950

Page	*Line*	*For*	*Read*
27	1 (heading)	Preparation of	Preparation of *ghee*

REFEREN

ORIGINAL ARTICLES

TESTS OF SOME PROPRIETORY INSECTICIDES

By P. Balarama Menon, C. M. Sen Gupta and B. C. Basu, Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh

(Received for publication on 16 October 1950)

THE utility of testing proprietory insecticides and drugs by research institutions and government establishments has been a subject of much discussion and difference of opinion among the research workers. On the one hand it has been put forward that it is no use to the country to test products, the formulae or compositions of which are not divulged by the manufacturers for trade reasons. On the other hand, it is pointed out that large sums of money could be saved for the country and much useful purpose gained by testing such products and correctly assessing the properties claimed for them in order that spurious claims may be exposed, useful products encouraged and industries of the country developed [Chopra and Basu, 1939]. It is now accepted on all hands that, in view of a large number of such drugs and insecticides of a proprietory nature being put into the market every day, it is necessary that they should be tested by the government or research institutes to assess their respective values for the benefit of the public. On this account the testing of products which are recieved for tests or otherwise put into the market, claiming therapeutic and insecticidal values. This paper reports the results of tests carried out in our laboratories on some of these products which were received by the Director, Indian Veterinary Research Institute from the manufacturers.

The proprietory preparations tested are given below:

1. Anofilum
2. Brizk
3. Gamatox Paste Dip
4. Kildem
5. Neocid-Geigy
6. No. 1050-Geigy
7. Pip
8. Pyrentol D 20
9. Pyro-colloid
10. Pyro-dust 1,500

Experimental methods

A series of experiments were conducted in each case to test the insecticidal value of the above preparations on different species of arthropods. Various dilutions of each were tried the details of which are presented in tables. Separate controls were kept for each series of experiment. The amount of spray used in the case of liquid preparations was on an average 0·015 c.c. per cubic foot.

1. *Anofilum.* This insecticide is marketed by the Indian Physiological Institute. The manufacturers claim that the product, when mixed with kerosene in the proportion of 16 ounces to one gallon, will make a most effective spray against all kinds of insects particularly mosquitoes, bugs, flies, etc.

Anofilum was tested in dilutions of 10 per cent and 50 per cent in kerosene oil on wild caught adults of house flies (*Musca* Linn. mostly *Musca nebulo* Wied.) and 10 per cent on mosquitoes (*Culex fatigans* Wied.) the details of which are presented in Tables I and II below.

TABLE I

Result of spraying Anofilum in different strengths on wild caught adults of Musca *spp.*

Time after spray	Number of flies used in each test	10 per cent			50 per cent		
		Date	Dead	Moribund	Date	Dead	Moribund
5 minutes	100	10-9-47	*nil*	*nil*	19-9-47	5	5
10 do.			*nil*	*nil*		14	6
30 do.			*nil*	5		25	15
45 do.			*nil*	15		28	12
1 hour			15	20		41	4
1½ hours			26	29		45	6
2 do.			50	20		65	15

TABLE II

Result of spraying Anofilum (10 per cent) on Culex fatigans *hatched out in the laboratory, 48 hours old*

Date	Number of mosquitoes used	Time after spray	Dead	Moribund	Alive
12-9-47	60	5 minutes	*nil*	2	58
		15 do.	3	3	54
		30 do.	3	6	51
		1 hour	3	12	45
		1½ hours	9	18	33
		2 do.	12	15	33
		3 do.	12	15	33
		4 do.	15	15	30

At the recommended dilution of 10 per cent, it had no immediate knock down effect and up to 45 minutes after spray no flies were killed but about 15 per cent were moribund. At the end of two hours after spray 50 per cent flies were dead and 20 per cent moribund. On the other hand a stronger dilution of 50 per cent Anofilum gave 20 per cent kill and 12 per cent moribund after 45 minutes and 65 per cent dead and 15 per cent moribund at the end of two hours. On mosquitoes a 10 per cent spray of Anofilum gave a kill of 5 per cent and 20 per cent moribund at the end of 45 minutes and 20 per cent kill and 25 per cent moribund at the end of two hours. It may be seen from the tables that Anofilum is a slow acting insecticide and the desired effect is obtained after a long period.

2. *Brizk.* Produced by the New International Trading Co., Bombay, it is claimed by the manufacturers to be the modern scientific insecticide containing 0·5 per cent Gamma BHC 'Gammexane' with pyrethrum. It is said to be effective against flies, mosquitoes, cockroaches, bugs and other insect pests.

This product was tested against house flies, mosquitoes and poultry lice, the results of which are presented in Tables III, IV and V.

TABLE III

Result of spraying Brizk on wild caught adults of Musca *spp.*

Date	Number of flies used	Time after spray	Dead	Moribund	Alive	Remarks
30-1-50	60	5 minutes	4	40	8	Sprayed at 11·25 hrs. majority knocked down
		30 do.	12	48		
		1 hour	20	40		
		1½ hours	30	30		
		2½ do.	44	16		
		3½ do.	56	4		

TABLE IV

Result of spraying Brizk on adults of Culex fatigans *hatched in the laboratory, 48 hours old*

Date	Number of mosquitoes used	Time after spray	Dead	Moribund	Alive	Remarks
22-2-50	60	5 minutes	12	48	..	Immediate knock down after spray
		30 do.	36	24	..	
		1 hour	42	18	..	
		1¼ hours	54	6	..	
		1½ do.	60	..	..	All dead

TABLE V

Result of spraying Brizk on poultry lice

Date	Bird number	Lice present	Result of spraying
13-3-50	9815	Menopon	Immediately after spraying many lice fell dead and dying on the floor. No lice found living after 24 hours
	9983	do.	do.
	9907	do.	do.
	9985	do.	do.
	9789	Menopon and Goniocotes	do.
	9162	do.	do.

It was found to be an effective insecticide giving quick knock down, a high percentage of kill and some residual action. Brizk emulsified with water and soap up to four times its volume or diluted 1 in 4 in kerosine has also given good results when used against flies (*Musca* Linn. mostly *M. nebulo* Wied.) and mosquitoes (*Culex fatigans* Wied.). Brizk rids poultry of poultry lice (*Menopon* Linn. sp. and *Goniocotes* Nitzsch) when used as a fine spray. Fine atomisation was required in order that the particles of spray penetrated the feathers and came in contact with the lice.

3. *Gamatox Paste Dip.* Made by Cooper, McDougall and Robertson and issued by Wilkinson, Heywood and Clark, Bombay, the manufacturers claim that 'this dip is based on Benzene Hexachloride (Gammexane) and for all practical purposes may be regarded as non poisonous. Gamatox paste dip is effective for the control of a very wide range of external parasties on sheep, cattle and other domestic animals and afford an important degree of protection against reinfestation by parasites. It is an all round stock dip which can be placed safely in the hands of most inexperienced stock owner. It is preferred to the arsenical and phenolic dips and is fully effective in all climates and stores well. In addition to its use in a bath, the wash can be employed at dipping strengths as a spray using any normal apparatus.

This insecticide was tested in varying dilutions in the field on ticks and lice, on dog, buffalo, goat and poultry. Against the common brown dog tick, *Rhipicephalus sanguine us* Latr. the dip gave very satisfactory results when used as a 1 in 20 dilution with water. Most of the ticks were found to have dropped down within 24 hours and reinfestation took place only after a week. When used in a dilution of 1 in 500 it took 72 hours for complete eradication and reinfestation took place within three days.

Against goat lice, *Bovicola caprae* (Gurlt) this insecticide gave complete kill within 24 hours when used in a dilution of 1 in 20 and 48 hours when used 1 in 500 dilution. The infested animals were sprayed with a Mish sprayer.

On buffalo lice, *Haematopinus tuberculatus* Giebel, the insecticide gave satisfactory results when diluted 1 pound to 50 gallons of water and sprayed with a stirrup pump. Infestation was reduced by more than half but complete eradication was not obtained. When used in a dilution of 1 in 20 complete kill was obtained within 24 hours.

On poultry lice, *Goniocotes* Nitzsch sp. and *Menopon* Linn sp., Gamatox paste dip used in a dilution of 1 in 10 and applied on the body with a cotton swab gave complete kill within 24 hours and reinfestation did not take place till after a fortnight.

4. *Kildem.* The manufacturers of this insecticide, the Standared Chemical and Pharmaceutical Co., Bombay, claim that it contains DDT with pyrethrum for killing mosquitoes, flies, fleas and other household pests.

Tests with this insecticide on *Musca* Linn spp. (mostly *M. nebulo* Wied.) in the laboratory gave good results. A 10 per cent solution in kerosene gave almost complete knock down within 10 minutes and a majority kill in 1½ hours. Whereas in the case of *Culex fatigans* Wied., 50 per cent were knocked down within 10 minutes after spray and a majority kill within two hours. The results of these tests are presented in Tables VI and VII.

TABLE VI

Result of spraying Kildem (10 per cent) on Culex fatigans, *hatched out in the laboratory, 48 hours old*

Date	Number of mosquitoes used	Time after spray	Dead	Moribund	Alive
5-9-47	100	Majority knocked down immediately after spray			
		5 minutes	..	50	50
		10 do.	16	35	49
		20 do.	20	50	30
		40 do.	26	49	25
		1 hour	28	50	22
		1½ hours	40	40	20
		2 do.	68	22	10
		2½ do.	75	15	10
		3 do.	90	..	10

TABLE VII

Result of spraying Kildem in different strengths on wild caught adults of Musca *spp.*

Date	Number of flies used in each test	Time after spray	5 per cent			10 per cent			Undiluted		
			Dead	Moribund	Alive	Dead	Moribund	Alive	Dead	Moribund	Alive
23-9-47	120	5 minutes	All flies apparently alright			48 knocked down 12 moribund			72 knocked down 48 moribund		
		10 ,,	12 knocked down			66 knocked down 42 moribund			All down on floor		
		30 ,,	6	24	90	6	108	6	36	78	6
		45 ,,	6	30	84	18	96	6			
		1 hour	12	30	78	60	60	..	78	42	..
		1½ hours	30	24	66	96	24	..	102	18	..
		2 do.	60	60	..	..	..	..	..	..	..

5. *Neocid-Geigy.* A DDT product manufactured by Messrs Geigy Insecticides Ltd., Bombay, is said to destroy bugs, lice, cockroaches, silver fishes, ants, etc., in dwellings and on human beings. It is claimed that Neocid containing 10 per cent DDT has residual and long lasting insecticidal properties and harmless to human beings and warm blooded animals.

In our series of experiments the following results were obtained. Neocid dusted into the hairs of goats freed the animals of lice within 24 hours. Both biting and sucking lice (*Bovicola caprae* Gurlt and *Linognathus* Endl. spp.) are killed. The animals continued to be free of lice for more than a week. It is also effective against *Haematopinus tuberculatus* Giebel, the buffalo lice. Though the animals were freed of lice within 24 hours, reinfestation took place within five days presumably because the animals washed the dust off by wallowing. The powder should be well rubbed in between the hairs. By dusting the affected parts cattle were freed of *Hyalomma aegyptium* Linn. within 24 hours but not much of residual effect was observed as reinfestation took place within a week.

6. *No. 1050-Geigy.* (Suspension powder for use against cattle ticks.) Geigy No. 1050 is claimed by the manufacturers to be a 50 per cent DDT suspension powder to be made up into a spray with the help of water. The ratio recommended is 20 pounds of the powder to 100 gallons of water and the rate of application, one quart per animal. For use in dip baths, 30 pounds of Geigy No. 1050 to 100 gallons of water are indictaed. Such dips are claimed to have a residual effect for a considerable length of time.

Five per cent spray of No. 1050 was found satisfactory in our experiments for the control of cattle ticks. The spray was applied by a Mish sprayer on the affected parts of the animal. The ticks treated belonged to the species *Hyalomma aegyptium* Linn. and *Boophilus australis* Fuller. Reinfestation did not take place for 15 days.

7. *Pip.* Pip, manufactured by the Bombay Chemicals Ltd., Bombay, is claimed to be a pyrethrum spray insecticide containing pyrethrum along with suitable activators and stabilising agents in an odourless mineral base oil. It is guaranteed to give a quick and cent per cent kill of all harmful insects like flies, mosquitoes, roaches, etc., and is said to be perfectly safe to human and all warm blooded animals. It is said to kill poultry lice and flies in the dairy.

Tests on this insecticide in our laboratory indicated that pip had all the properties of a good pyrethrum insecticide. On house flies (*Musca* Linn. spp. mostly *Musca nebulo* Wied.) and mosquitoes (*Culex fatigans* Wied.) it had a quick knock down effect and percentage of kill obtained was very high. On poultry lice (*Menopon* Linn. sp. and *Goniocotes* Nitzsch sp.) too, Pip was quite effective but much depends on the method adopted in applying the insecticide. Fine atomisation is required when used as a spray so as to ensure that the particles of the spray get inside between the feathers. The results of tests on these insects are presented in Tables VIII, IX and X.

TABLE VIII

Result of spraying pip on wild caught adults of Musca *spp.*

Date	Number of flies used	Time after spray	Dead	Moribund	Alive	Remarks
16-4-48	50	5 minutes	20	28	2	Immediate knock down after application of spray
		10 ,,	42	8	..	
		15 ,,	43	7	..	
		20 ,,	45	5	..	
		1 hour	50	..	..	All dead

TABLE IX

Result of spraying pip on Culex fatigans, *hatched out in the laboratory, 24 hours old*

Date	Number of mosquitoes used	Time after spray	Dead	Moribund	Alive	Remarks
						Sprayed. All knocked down immediately
15-4-48	50	5 minutes	22	27	1	
		10 ,,	28	22	..	
		15 ,,	30	20	..	
		20 ,,	32	18	..	
		30 ,,	32	18	..	
		1 hour	35	15	..	
		1½ hours	40	10	..	
		2 do.	50	..	..	All dead

TABLE X

Result of spraying pip on poultry lice

Date	Fowl number	Lice present	Result of spraying after 24 hours
3-5-48	7	Menopon and Goniocotes	None living
	8	Goniocotes	do.
	4	do.	do.
	6	Menopon	All dead excepting a small one

8. *Pyrentol D 20.* This is manufactured by the Standard Chemical and Pharmaceutical Co., Bombay, and is said to kill a large number of household pests.

Tested on house flies (*Musca* Linn. spp. mostly *Musca nebulo* Wied.) it was found to possess good insecticidal properties. It had quick knock down effect and the percentage of kill obtained was high. A dilution of 5 per cent in kerosene gave 40 per cent dead and 50 per cent moribund in 2 hours, where as in 4 hours 90 per cent kill was obtained. On mosquitoes (*Culex fatigans* Wied.), however, 60 per cent kill and 20 per cent moribund was obtained after one and half hours, and a kill of 85 per cent was obtained after 3 hours. The results of these tests are given in Tables XI and XII.

TABLE XI

Result of spraying Pyrentol D 20 (5 per cent) on wild caught adults of Musca *spp.*

Date	Number of flies used	Time after spray	Dead	Moribund	Alive	Remarks
4-9-47	60	10 minutes	Paralysed and lying on their backs			All knocked down after spray
		45 ,,	do.			
		1 hour	12	42	6	6 recovering
		2 hours	24	30	6	do.
		3 ,,	36	18	6	do.
		4 ,,	54	. .	6	6 recovered

TABLE XII

Result of spraying Pyrentol D 20 (5 per cent) on Culex fatigans, *hatched out in the laboratory, 48 hours old*

Date	Number of mosquitoes used	Time after spray	Dead	Moribund	Alive	Remarks
4·9·47	60	5 minutes	6	30	24	Sprayed 36 on floor
		20 ,,	18	24	18	
		1 hour	30	15	15	
		1½ ,,	36	12	12	
		2½ ,,	45	9	6	
		3 ,,	51	3	6	

9. *Pyro-colloid.* This insecticide is marketed by the Bombay Chemicals Ltd., Bombay. The manufacturers claim that it is a colloidal form of pyrethrum which is to be diluted with water before use in different proportions. It is said to be nontoxic and can be safely used on milch cattle or cattle which have the habit of licking their body.

This insecticide was tested in our laboratory as well as in the field in different dilutions on flies, mosquitoes and ticks. On flies (*Musca* Linn spp. mostly *Musca nebulo* Wied.) it had good knock down effect and gave a high percentage of kill in dilutions of up to 1 in 600. At a dilution of 1 in 1200 it was fairly effective but was not effective at a dilution of 1 in 2400. On mosquitoes (*Culex fatigans* Wied.) a 1 in 800 dilution of pyro-colloid gave fairly good result. The results of these tests are available in Tables XIII and XIV. Pyro-colloid at a dilution of 1 in 100 and 1 in 300 when tested on *Hyalomma aegyptium* Linn. in the field, gave a kill of less than 50 per cent.

10. *Pyro-dust 1500.* This is claimed by the manufacturers Bombay Chemicals Ltd., Bombay to be a plant product harmless to warm blooded animals, giving immediate knock down of insects. Prepared from Indian grown pyrethrum it is said to be chemically stable and to act as both contact and stomach poison.

This dust was tested on cattle tick *Hyalomma aegyptium* Linn., both in our laboratory and in the field. In the laboratory, tests with 41 ticks, 17 were found paralysed and 24 killed after five and half hours. The result is given in Table XV. In field tests, however, a kill of about 50 per cent was obtained within 24 hours.

TABLE XIII

*Result of spraying **Pyro-colloid** in different strengths on wild caught adults of **Musca** spp.*

Date	Number of flies used in each test	Time after spray	1 in 600				1 in 1200				1 in 2400			
			Knock down	Mori bund	Dead	Alive	Knock down	Mori bund	Dead	Alive	Knock down	Mori bund	Dead	**Alive**
6-5-49	50	Immediately after spray	46	..	..	4	40	..	..	10	6	..	..	44
		10 minutes	48	..	..	2	44	..	..	6	15	..	..	35
		20 ,,	28	20	..	2	30	15	..	5	32	3	..	15
		50 ,,	10	23	13	4*	20	9	12	9*	4	..	..	46*
		1½ hours	10	3	33	4	11	4	24	11*	Mostly recovered			
		2 ,,	5	5	36	4	5	2	30	13*				

* Recovered

TABLE XIV

Result of spraying Pyro-colloid (1 in 800) on Culex fatigans, *hatched out in the laboratory 48 hours old*

Date	Number of mosquitoes used	Time after spray	Dead	Moribund	Alive	Remarks
26-6-50	60	5 minutes	..	33	27	Sprayed. Good knock down
		15 ,,	6	30	24	
		45 ,,	12	30	18	
		1 hour	24	27	9	
		1½ hours	27	4	9	
		2 ,,	39	12	9	
		3 ,,	42	9	9	

TABLE XV

Result of dusting Pyro-dust 1500 on cattle tick (Hyalomma aegyptium)

Date	Number of ticks used	Time after spray	Dead	Paralysed	Alive	Remarks
26-6-50	41	30 minutes	..	41	..	Dusted thoroughly
		1 hour	3	38	..	
		1½ hours	4	37	..	
		2 ,,	9	32	..	
		2½ ,,	14	27	..	
		3½ ,,	20	21	..	
		4½ ,,	24	17	..	
		5½ ,,	26	15	..	

SUMMARY

Ten proprietory insecticides, *viz.*, Anofilum, Brizk, Gamatox paste dip, Kildem, Neocid, No. 1050-Geigy, Pip, Pyrentol D 20, Pyro-colloid and Pyro-dust were tested in varying dilutions on different species of arthropods. Brizk, Kildem (10 per cent), Pip, Pyrentol D 20 (5 per cent) and pyro-colloid (1 in 600) were found quite effective against houseflies (*Musca* Linn. Spp. mostly *Musca newbulo Wied.*) and mosquitoes (*Culex fatigans* Wied.). Anofilum, though effective against the same species, had a delayed action. Brizk and Pip rid poultry of poultry lice (*Menopon* Linn sp. and *Goniocotes* Nitzsch). Pyro-colloid and Pyro-dust 1500 when tested against cattle tick (*Hyalomma aegyptium* Linn.) in the field gave about 50 per cent kill within 24 hours. Gamatox paste dip in different dilutions was found effective against the common brown dog tick (*Rhiphicephalus sanguineus* Latr.), goat lice (*Bovicola caprae* (Gurlt), buffalo lice (*Haematopinus tuberculatus* Giebel) and poultry lice (*Menopon* Linn sp. and *Goniocotes* Nitzsch) in field trials. It possesses both residual as well as high killing properties.

Neocid dusted into the hairs of animals controlled goat lice (*Bovicola caprae* Gurlt and *Linognathus* Endl.), buffalo lice (*Haematopinus tuberculatus* Giebel) and cattle tick (*Hyalomma aegyptium* Linn.) within 24 hours. The residual effect varied from 5 to 8 days.

No. 1050—Geigy, when sprayed in a 5 per cent suspension in water, successfully controlled cattle ticks (*Hyalomma aegyptium* Linn. and *Boophilus australis* Fuller). Reinfestation did not take place within 15 days.

ACKNOWLEDGMENT

The authors' thanks are due to Dr. S. Datta, Director, Indian Veterinary Research Institute and Dr. H. N. Ray, Officer-in-charge, Section of Parasitology, for all possible facilities for conducting these experiments.

REFERENCES

Bishopp, F. C. (1946). The insecticide situation. *J. Econ. Ent.* **39**, 4, 449-459

Buxton, P. A. (1945). The use of the new insecticide DDT in relation to the problems of tropical medicine. *Trans. Roy. Soc. Trop. Med. Hyg.* **38**, 5, 367-400

Chopra, R. N. and Basu, B. C. (1939). Failure of 'M3' in prophylaxis of Indian strains of Malaria. *J. Mal. Inst. Ind.* **2**. 3, 253-255

Frear, Donald E. H. (1943). Chemistry of Insecticides and Fungicides. Chapman Hall, London

Pruthi, H. S. and Nasir M. (1945). Tests with DDT and 666 as Agricultural Insecticides in India. *Indian Fmg.* **6**, 11, 506-510

Puri, I. M. (1947). The practical application of DDT for malaria control in rural and urban areas in India. *Indian J. Mal.* **1**, 1, 211-220

Smith Bernard and Petty, B. K. (1946.) What we know about DDT. *Fmg. S. Afr.* **21**, 245, 533-538

VALUE OF A MIXTURE OF DERRIS ROOT POWDER AND DDT IN THE CONTROL OF POULTRY LICE

By P. BALARAMA MENON, C. M. SEN GUPTA and B. C. BASU, Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh

(Received for publication on 16 October, 1950)

THE Animal Diseases and Pests Committee of the Indian Council of Agricultural Research in 1947 recommended that experiments on the use of a mixture of derris and DDT to control the external parasites of poultry should be conducted at the Indian Veterinary Research Institute. Accordingly, a series of experiments were conducted to test the efficacy of a mixture of derris and DDT along with a few other insecticides on poultry lice. This paper reports the results of these experiments.

Poultry and poultry products are of immense value in the economy of the country specially when there is shortage of food materials. In the undivided India there were 1732 lakhs of fowls of which 522 lakhs were laying hens producing annually 33648 lakhs of eggs. It has been estimated that the total value of birds and eggs sold amount to Rs. 750 and 525 lakhs respectively.

Lice in poultry are a serious problem to the poultry breeder. They are often present in sufficient numbers to cause great discomfort and even death.. The irritation caused by them makes the bird exceedingly restless with consequent lowering of its condition and egg production.

Uptil 1939 the standard treatment for controlling these insects was the use of sodium fluoride by dipping, dusting or the pinch method. With the advent of the new insecticides, much advancement has been made in the control of these pests, though the use of a few other chemicals as well as vegetable products has also been suggested. In brief, the record of previous work of importance in this connection may be summarized in the following paragraph.

Bishopp and Wood [1917] appear to have first successfully controlled chicken lice with sodium fluoride. Earlier, Pearl *et al.* [1915] and Lamson [1917] used mercurial ointment but it was never popular and is not used nowadays. Abbott [1919] wrote on the use of naphthalene and allied products and found that mercurial ointment, sodium fluoride, sulphur and pyrethrum were the most effective in controlling lice on poultry. Naphthalene is low in its toxicity to the pest and dangerous when applied to the chickens in excess of ten per cent. McIndoo *et al.* [1919] and Wells *et al.* [1922] found derris to be the safest and effective lousicide. Parman *et al.* [1928] administered many compounds orally but to no effect. Telford [1944] found that a mixture of sodium fluoride (33 per cent) and DDT (4 per cent) was a very good lousicide. Telford again in 1945 tested 37 louse powders to determine the effect of treatment on lice and the residual effect of each drug up to a certain period of time. For the convenience of subsequent workers the results

7(a) TABLE I

Trial number	Formula	Grams per bird	Number of birds	Observation period	Species of louse			Residual effect	Effect of treatment on lice
					Body	Shaft	Fluff		
1	DDT 4 per cent in pyrax	6·2	7	30 days	..	..	..	yes	Complete kill within 28 hours
2	DDT 2 per cent in pyrax	7·2	2	30 days	..	..	..	yes	Complete kill within 28 hours
3	DDT 1 per cent in pyrax	8·0	1	30 days	..	..	..	yes	Complete kill within 28 hours
4	DDT 0·5 per cent in pyrax	11·8	4	30 days	..	..	..	yes	Complete kill within 28 hours
5	DDT 0·25 per cent in pyrax	6·5	4	52 hrs.	..	..	..	—	Very poor kill
6	DDT 0·125 per cent in pyrax	6·9	4	52 hrs.	..	..	..	—	Very poor kill
7	Sodium fluoride 33 per cent in pyrax	7·8	6	30 days	..	..	..	yes	Complete kill within 52 hours
8	Sodium fluoride 15 per cent in pyrax	8·4	4	4 days	..	..	..	yes	Two shaft lice remaining at 4 days
9	Lethane B-71 10 per cent in pyrax	8·2	4	7 days	..	..	..	no	Three shaft lice remaining at 4 hours
10	Lethane B-71 5 per cent, mic. wet sulphur 30 per cent in pyrax.	5·1	4	15 days	..	..	..	yes	Complete kill within 26 hours
11	Phenothioxine 10 per cent in pyrax	6·3	12	11 days	..	..	..	no	Five shaft, 1 body louse remaining at 48 hrs.
12	Phenothioxine 10 per cent in bentonite	5·5	4	11 days	..	..	..	no	Complete kill within 24 hours
13	Phenothioxine 5 per cent mic. wet sulphur 30 per cent in pyrax.	6·5	4	15 days	..	..	..	yes	Complete kill within 24 hours
14	Phenothioxine 10 per cent in pyrax (fusion mixture)	6·5	4	11 days	..	..	..	no	Complete kill within 24 hours
15	Phenothioxine 10 per cent in bentonite (fusion mixture).	5·5	4	11 days	..	..	..	no	Complete kill within 24 hours
16	Genicide (xanthone) 30 per cent in pyrax	6·8	4	9 days	..	..	..	no	6 body, 5 fluff lice remaining at 28 hours
17	NH dust 10 per cent in pyrax	9·4	4	5 days	..	..	..	no	Complete kill within 28 hours
18	NH dust 5 per cent mic. wet sulphur 30 per cent in pyrax.	7·0	4	15 days	..	..	..	yes	3 shaft lice remaining at 26 hours complete eventual kill
19	Thanite 5 per cent in pyrax	9·7	4	9 days	..	..	..	no	Complete kill within 4 hours
20	Thanite 5 per cent, mic. wet sulphur 30 per cent in pyrax	5·1	4	15 days	..	..	..	yes	Complete kill within 26 hours

21	Diphenyl 5 per cent, mic. sulphur 30 per cent, bentonite 7·5 per cent in pyrax	7·6	4	15 days	..	..	..	yes	9 body, 8 shaft 5 flufflice, remaining at 26 hours complete eventual kill
22	Diphenyl 2 per cent, AR 50 * 5 per cent in pyrax	11·2	4	5 days	..	..	..	no	Poor kill
23	o-Nitrodiphenyl 10 per cent in pyrax	11·1	4	30 days	..	..	..	no	Complete kill within 5 hours
24	Kryocide (cryolite) 30 per cent in pyrax	7·9	4	30 days	..	..	..	yes	2 body lice remaining at 5 days
25	Mic. wettable sulphur	10·4	4	30 days	..	..	..	yes	Complete kill within 5 days
26	Orthophenylphenate 10 per cent in pyrax	10·9	1	4 days	..	..	..	—	No control
27	Nicotine 0·5 per cent (Black leaf 155) in pyrax	6·3	6	30 days	..	..	..	no	Complete kill of body lice within 4 hours. Poor kill of shaft lice
28	Tetramethyl thiouram-disulfide 10 per cent in pyrax	10·1	4	6 days	..	..	..	yes	One shaft louse remaining at 3 days
29	2 per cent conc. of tetramethylthiouram-monosulphate 90 per cent and tetra-methyl thiouram-di-sulphide 10 per cent in pyrax	7·7	4	6 days	..	..	..	yes	Complete control within 28 hours
30	2·4 dinitor-o-cyclohexyl phenol 5 per cent in pyrax	9·5	4	6 days	..	..	..	no	3 shaft lice remaining at 4 hours. Stains hands and feathers
31	Sabadilla 10 per cent, hydrated lime 10 per cent in pyrax	7·0	2	3 days	..	..	..	no	Very poor control
32	Derris (5 per cent roteno ne) 10 per cent in pyrax	6·1	4	8 days	..	..	..	yes	Complete kill within 24 hours
33	2, 4 dinitroanisole 2 per cent in pyrax	9·0	4	12 days	..	..	..	—	No control
34	2, 4 dinitroanisole 2 per cent, IN-930 2 per cent in pyrax	7·3	4	12 days	..	..	..	—	No control
35	Pyrethrum formula I†	8·5	4	14 days	..	..	..	yes	Complete kill within 4 hours
36	Pyrethrum formula II	9·2	4	8 days	..	..	..	—	Five body lice remaining at 8 days
37	Pyrethrum formula III	8·2	4	7 days	..	..	..	no	14 body, 3 shaft lice remaining at 7 days

* AR 50 is a polymethylated naphthalene.

† A proprietary louse powder containing : pyrethrins·0066 per cent, sulphur 30 per cent, naphthalene 5 per cent, petroleum hydrocarbons 0·45 per cent, inert 64·48 per cent. Formula II and III are ½ and ¼ dilutions respectively of the above with pyrax.

of his elaborate work are summarized in Table I as the literature is not easily available to workers in the field.

MATERIALS AND METHODS

The 58 birds used for this experiment were white leghorns each about 24 months old. The species of lice present on them belonged to the genera *Menopon* and *Gonicotes*. Birds showing less than 50 parasites each were discarded. They were divided into nine batches, 4 batches of eight birds each, three of six birds and two of four birds each. Amongst the first four batches of eight birds each, one batch was used for testing derris root powder, another for a mixture of derris and DDT and the remaining two batches for DDT in different strengths. Of the three batches of the second series, two were used for testing sodium fluoride in different strengths and one batch was kept as control. Of the two batches of four birds each one was used to test Gammexane and the other for pyrethrum dust. The details of these experiments are presented in Table II.

The dilutions of the insecticides tested were as follows :

1. Derris (with 5 per cent rotenone content) ten per cent in talc.
2. D D T five per cent in talc.
3. D D T 2·5 per cent in talc.
4. A mixture of equal parts of 1 and 2.
5. Sodium fluoride 33 per cent in talc.
6. Sodium fluoride 20 per cent in talc.
7. Gammexane D 025 containing 0·6 per cent Gamma Isomer.
8. Powdered dried pyrethrum flowers.

A salt shaker type applicator (old cuticura powder tins suitably modified) was used for dusting individual birds. The dust was rubbed in between the feathers by the hand. The amount of dust applied to each bird was determined by weighing the applicator both before and after use. Each batch of birds was kept in a seperate cage. Daily examination of the birds was conducted in each case to note the increase or decrease in lice population. After a week the experimental birds were released to mix with the control birds. Each experimental bird was examined every alternate day till reinfestation took place.

EXPERIMENTAL RESULTS

The results obtained in testing the various insecticides are tabulated in Table II.

Good residual effect was exhibited by D D T (5 per cent and 2·5 per cent), Gammexane D 025 (0·6 per cent Gamma Isomer) Derris (10 per cent) and mixture of equal parts of derris (10 per cent) and D D T (5 per cent) and complete extermination was obtained in all these cases within 24 to 28 hours.

Sodium fluoride (33 per cent) killed all lice within 60 hours but did not show any noticeable residual effect.

Pyrethrum, while lacking in the residual properties of rotenone, DDT and Gammexane D 025, showed quick knock down action and complete kill was obtained within four hours.

TABLE II

Trial number	Formula	Date of application	Number of birds	Quantity used	Effect of treatment	Genera of lice	Reappearance of lice	Residual effect	Remarks
1	Derris (5 per cent rotenone) 10 per cent in talc	25-5-49	8	8·0 gm. per bird	Complete kill within 28 hrs.	Menopon and Gonicotes	17 days	yes	
2	DDT 5 per cent in talc	25-5-49	8	8 gm. per bird	Complete kill within 24 hrs.	do.	24 days	yes	
3	DDT 2·5 per cent in talc	25-5-49	8	7·8 gm. per bird	do.	do.	22 days	yes	
4	Mixture of equal parts of 1 and 2.	25-5-49	8	8·0 gm. per bird	do.	do.	23 days	yes	
5	Sodium fluoride 33 per cent in talc	25-5-49	6	7·5 gm. per bird	Complete kill within 60 hrs.	do.	10 days	poor	
6	Sodium fluoride 20 per cent in talc	25-5-49	6	7·8 gm. per bird	Almost complete kill within 60 hrs. excepting a few shaft lice.	do.	—	—	A few Shaft lice noticed throughout the observation period.
7	Gammexane 0·6 percent in talc	25-5-49	4	7·5 gm. per bird	Complete kill within 24 hrs.	Menopon	40 days	yes	
8	Powdered dried pyrethrum flowers	25-5-49	4	8·0 gm. per bird	Complete kill within 4 hrs.	do.	5 days	No.	Quick knockdown.

Birds dusted with Gammexane D 025 (0·6 per cent gamma isomer) 10 per cent derris, 5 per cent DDT and a mixture containing equal parts of 10 per cent derris and 5 per cent DDT had louse infestation approximating their original population within 40, 20, 35 and 30 days respectively.

Throughout the experiment the louse populations of the control birds were either stationary or found increasing.

SUMMARY

A series of experiments were conducted to determine the effectiveness of DDT derris powder, mixture of derris and DDT, Gammexane D 025, Pyrethrum and sodium fluoride on poultry lice. The insecticides were used in various proportions.

Gammexane D 025, 5 per cent and 2·5 per cent DDT and a mixture containing equal parts of 10 per cent derris and 5 per cent DDT were found equally effective both in killing and residual effect.

Ten per cent derris had similar killing properties but was found to have less residual effect.

Pyrethrum gave quick knock down and complete kill within four hours but had no residual effect.

Thirty three per cent sodium fluoride had practically no residual effect but gave complete kill within 60 hours.

ACKNOWLEDGMENTS

The writers are grateful to Dr S. Datta, Director, Indian Veterinary Research Institute and Dr H. N. Ray, Officer-in-charge, Section of Parasitology or giving them facilities for this work.

REFERENCES

Abbott, W. S. (1919). Naphthalene vs. chicken lice. *J. econ. Ent.* 12 (5), 397-402

Bishopp, F. C. and H. P. Wood (1917). Mites and lice on poultry. U. S. D. A. *Farmer's Bull.* 801

Hermes, William B. (1939). *Medical Entomology*, Macmillan Co. New York

Lamson, G. H. (1917). Mercurial ointment, an effective control of hen lice. *J. econ. Ent* 10 (1), 71-4

McIndoo, N. E., A. F. Sievers and W. S. Abbott (1919). Derris as an insecticide. *J. agric Res.* 17 (5), 177-200

Parman, D. C., W. S. Abbott, J. J. Culver and W. M. Davidson (1928). Ineffectiveness of internal medication of poultry for the control of external parasites. *U.S.D.A. Tech. Bull*, 60

Pearl, Raymond, F. M. Surface and M. R. Curtis, (1915). *Diseases of poultry*, Macmillan Co.

Telford, Horace S. (1944). Chicken lice control. *Soap and Sanitary Chemicals* 20 (8), 113, 139

Telford, Horace S. (1945). New insecticides for chicken lice control. *J. econ. Ent.* 38 (5), 573-576

Wells, R. W., F. C. Bishopp and E. W. Laake (1922). Derris as a promising insecticide. *J. econ. Ent.* 15 (1), 90-5

INVESTIGATIONS ON TRACE ELEMENT COPPER

I. THE DISTRIBUTION OF COPPER IN BIOLOGICAL MATERIALS

By K. Sahai and N. D. Kehar, Animal Nutrition Section, Indian Veterinary Research Institute, Izatnagar

(Received for publication on 1 June 1951)

THERE are now no less than thirteen mineral elements known to be essential for animal life. These are Ca, P, Mg, Na, K, Cl, S, Fe, Cu, Mn, Zn, I and Co. Five of these, namely Cu, Mn, Zn, I and Co, have, in laboratory jargon, been dubbed 'trace' elements since they have been shown to function in quantities so minute that they may appropriately be described as traces.

Copper as a metal has been used since very early times, the oldest specimens of cast copper dating back to 4000 B. C. The presence of this metal in biological materials, however, remained undetected until the beginning of the nineteenth century. Bucholz [1816] and Meissner [1817] were probably the first to establish definitely the presence of copper in plant life. The presence of copper in animal organism was for the first time detected by Sarzeau [1830]. Chevruel [1868], in a review on the copper content of biological material, suggested that the metal was widely distributed, but it was not until the observations of Bodansky [1921] and Mc Hargue [1925, 1926], however, that copper became recognized as other than an accidental constituent.

Bertrand [1920] and Guerithault [1920] suggested that copper should be placed in the group of catalytic elements found in plants. Maquenne and Demoussy [1920] concluded that copper in some way aided the vital functions of the plant. McHargue [1927] suggested that copper together with other minor elements played an important role in life processes. The classical researches of Hart and coworkers [1928] suggested the role of copper in haematopoiesis. The specificity of copper as a supplement of iron in the regeneration of haemoglobin has since been demonstrated by Elvehjem and Hart [1929], Keil and Nelson [1931], Hamilton, Hunt and Carroll [1933], Meyers, Remp and Bing [1934], Potter, Elevehjem and Hart [1938], and Frost, Potter, Elvehjem and Hart [1940]. A specific effect on red cell production has been attributed to copper by Oda [1932], Schultze [1932], Stein and Lewis [1933], Binnet and Strumza [1934], Somogyi [1935] and others.

The livestock malady which has been found to be associated with copper deficiency has been reported from widespread regions of the world. Sjollema [1933] described a disease of cattle in parts of Holland called 'Lecksucht', characterized by anorexia, emaciation, anaemia and diarrhoea, which responded to copper therapy. In Florida a condition in cattle with similar symptoms and known as 'Saltsick' was reported by Becker *et al.* [1931] to respond to Fe and Cu therapy. Bennetts and Chapman [1937], found that a usually fatal condition of ataxia in new born lambs, enzootic in certain parts of western Australia, was associated with a deficiency of copper in the mother and could be avoided by treating the ewes with copper during the period of gestation. Confirmation of their discovery has been reported from South Australia by Bull *et al.* [1938] and from England by Dunlop and Wells [1938], where a similar malady known as 'swayback' occurs in certain restricted areas. An account of depigmentation, a new dietary deficiency disease, as cured by copper has been given by Gorter [1935] and Mc Collum *et al.* [1939].

Adequate amount of copper in the diet has been reported by Black *et al.* [1937] to show a more efficient utilization of food, greater weight gain, greater energy storage and greater accumulation of fat and protein. In larger doses copper is extremely toxic and heavy losses due to copper poisoning have been reported by Boughten and Hardy [1934] and Eden [1940]. The toxic level, however, has been reported by Eden [1940], and Pullar [1940] to vary with the type of diet as also with the species.

The above observations clearly show that copper occupies a very important place in the group of 'trace' elements which are essential for animal life.

In view of the fact that there is almost a complete lack of information on the significance of trace element, copper, in the nutrition of animals in India, where livestock play an important role in the agricultural economy, a systematic investigation on copper in relation to cattle nutrition was undertaken in these laboratories in 1944.

The study of the nutritional role of an element necessitates primarily a knowledge of its distribution in biological materials. The information on the copper content of biological materials is on the whole, meagre and whatever is available relates to foreign countries. It has been observed by Kehar and Momin [1950] that climate, soil and environmental conditions exercise a great influence on the chemical make up of feeds. The frequent data can, therefore, be of little value in providing accurate information. The present paper, therefore, which is the first of a series, has been devoted to the study of the copper content of cereal straws, grasses, leafy fodders, cultivated plants, grains, seeds and their by-products and also the different organs and blood of normal animals.

The feeds for analysis were either obtained from the Institute Estate or a nursery of the Forest Department in Clutterbuckganj about four miles from this Institute. Some of the samples were procured from the market. The blood and tissues for analysis were collected from the normal animals.

EXPERIMENTAL

The method used for the estimation of copper is a slight modification of Eden and Green [1940] which is based on the diethyl—dithiocarbamate method of Callan and Henderson [1929]. The salient features of the method used are as follows:

One gm. of the dry material (1-5 gm. of wet tissues or 5 ml. of blood) is taken in a pyrex test tube, 200 mm. × 25 mm. 1·5 ml. of A. R. sulphuric acid, 2 ml. of 70 per cent Bakers Analysed perchloric acid, 1 ml. water and two glass beads are added and, the mixture heated over the lowered flame of a bunsen burner. Heating is continued until an almost homogenous dark brown liquid is obtained. The tube is now cooled and 1 ml. perchloric acid and 2 ml. A. R. nitric acid are added and heating resumed. No undue frothning takes place and the dark brown colour gradually lightens to faint greenish yellow or colourless. The tube is cooled and in order to ensure the removal of the last traces of organic matter, heating is again resumed after the addition of 0·5 ml. of perchloric acid and the same volume of nitric acid. After the digestion is complete, the flame is slightly raised and heating continued until thick white fumes of perchloric acid are no longer evolved. A little water is added to the tube while still warm, to keep in solution the salts separating out in the final stages of digestion.

The liquid in the tube is now diluted to about 10 ml. and 5 ml. of each of a 5 per cent solution of sodium pyrophosphate and 10 per cent solution of sodium citrate are added and made alkaline with ammonia. The precipitate formed is rendered granular by heating the tubes in a water bath for 20 minutes. The tubes are next cooled and the contents diluted with water. A drop of 40 per cent solution of NaOH is added and is followed by 10 ml. of redistilled amyl alcohol and the volume made up with water to 50 ml. mark. Two ml. of 0·5 per cent sodium diethyl-dithio carbamate solution are now added and the tube is closed with a rubber stopper, and vigorously shaken for about a minute. The amyl alcohol takes up the yellow copper compound and is filtered through acid extracted filter paper.

For colour comparison convenient matching ranges are made by taking in a 200 mm. × 25 mm. pyrex test tubs, 0·5 ml., 1 ml., 1·5 ml. and 2 ml. of a standard solution of copper sulphate containing 0·01 mgm. copper per ml. and adding the same quantities of water, pyrophosphate and citrate, making alkaline with ammonia, heating in a water bath, cooling, diluting, adding NaOH, etc., as after combustion to the unknowns; and the one nearest to the unknown was used.

The accuracy of the modified method was determined by performing a number of recovery tests. The recovery worked out to be of almost the same order as with the original method.

Greatest care was observed to prevent the introduction of any copper from outside. Even the reagents of the highest grade obtainable were not used until found to be copper free by actual test. The water used was redistilled from all-glass apparatus.

All analyses were run in triplicate and to one of them was added a known quantity of copper for recovery. If a satisfactory recovery of the added copper was obtained it was felt that the copper content of the samples was being accurately determined.

RESULTS AND DISCUSSION

The copper content of various animal feeds—straws, green feeds and concentrates which constitute the principal basal diet for live stock in various tracts of the country are given in Table I. The results have been calculated on dry weight basis and presented in mg. of copper per kg. of dry sample.

TABLE I

The copper content of some of the common animal feeds

Botanical name	Popular name	Copper content in mg. per kg. (dry basis)
Avena sativa	(Straws) Oat straw	3·6
Hordeum vulgare	Barley straw	3·9
Triticum vulgare	Wheat straw	4·1
Oryza sativa	Rice straw	4·3
Andropogon sorghum	*Jowar* straw	4·4
Pennisetum typhoideum	*Bajra* straw	4·5
Cicer-arietinum	Gram straw	4·7
	Green feeds	
Dichanthium annulatum	*Bara jargi*	5·9
Moringa pterygosperma	*Sanjna*	5·9
Panicum phragmatoides	....	6·0
Iscilma laxum	*Musel*	6·2
Anogeissus latifolia	*Bakli*	6·4
Apluda mutica	*Bhanjura*	6·4
Eremapogon faveolatus	*Murrjhana*	6·4
Setaria du-toits-krall strain	....	6·4
Bothriochloa pertusa	*Choti jargi*	6·6
Eulalopsis binata	*Baib*	6·6
Cynodon plectestachyum	Giant star grass	6·8
Morus alba	*Tutri*	6·8
Cynodon dactylon	*Dub*	7·1
Andropogon sorghum var. *sudanensis*	Sudan grass	7·1
Kydia calycina	*Pula*	7·5
Ficus glomerata	*Gular*	7·6
Pisum sativa	Pea plant green	7·6
Banhinia purpuria	*Khariwal*	7·7
Grevia elastica	*Dhaman*	7·7

TABLE I—*contd.*

The copper content of some of the common animal feeds

Botanical name	Popular name	Copper content in mg. per kg. (dry basis)
	(Straws)	
Digitaria swasilandensis	....	7·8
Ongenia dalbergiodes	*Sandan*	8·1
Bothriochloa intermedia	*Sandhaur*	8·2
Avena sativa	Oat plant green	8·2
Ficus infectoria	*Pakar*	8·3
Andropogon contortus	Spear grass	8·3
Digitaria seriata	....	8·4
Azadirachta indica	Neem	8·5
Digitaria peutzii	....	8·5
Terminalia tomentosa	*Sain*	8·6
Andropogon sorghum	*Jowar* green	8·7
Sporobolus arabicus	*Usar*	8·7
Adina cardifolia	*Haldu*	8·8
Pennisetum purpureum	Elephant grass	9·0
Ficus religiosa	*Pipal*	9·1
Ficus bengalensis	*Bargad*	9·2
Panicum maximum	Guinea grass	9·2
Trifolium resupinatum	*Shaftal* grass	9·2
Pennisetum typhoideum	*Bajra* green	9·6
Morus sp.	*Tut*	9·8
Acacia arabica	*Babul*	9·9
Banhinia variegata	*Kachnar*	9·9
Trifolium alexandrinum	Berseem grass	10·4
Pennisetum purpureum	Napier grass	10·6
Cenchrus ciliaris	*Anjana*	10·8
Medicago sativa	Lucerne grass	10·9
Elusine aegyptiaca	*Maka kewai* grass	11·0

TABLE I—*contd.*

The copper content of some of the common animal feeds

Botanical name	Popular name	Copper content in mg. per kg. (dry basis)
	(Straws)	
Hordeum vulgare	Barley young	11·9
Stereosperma sanveolens	*Padal*	17·8
	Concentrates	
Sesamum indicum	*Til* cake	9·2
Gossypium	Cotton seed cake	9·6
Andropogon sorghum	*Jowar*	9·8
Oryza sativa	Rice	9·8
Brassica compestris	Rape cake	10·6
Zea mays	Maize	10·9
Triticum vulgare	Wheat	11·4
Linum sitatissimum	Linseed cake	11·6
Cicerarietinum	Gram	11·8
Pennisetum typhoideum	*Bajra*	12·4
Mangifera indica	Mango seed kernel	12·4
Brassica alba	*Sarson* cake	13·3
Phaseolus mungo var. *radiatus*	*Urad*	13·3
Ervum lens	*Masur*	13·4
Phaseolus mungo, var. *glabar*	*Mung*	14·5
Arachis hypogaea	Groundnut cake	16·6
Cajanus indicus	*Arhar*	17·2

The copper content ranged between 3·6 mg. in oat straw to 17·8 mg. in *Stereo sparmuna snaviolens* (*padal*) leaves and a critical examination of the results suggests a tentative grouping on the basis of their copper content. When arranged in ascending order the cereal straws with copper content ranging from 3·6 mg. per kg. in oat straw to 4·7 mg. per kg. in gram straw constitute the first group. The green feeds which include a variety of samples representing grasses, leafy fodders and cultivated plants of mixed botanical composition and possess medium copper content ranging from 5·9 mg per kg. in *Dichanthium annulatum* (*bara jargi*) to 11. 9. mg. per kg. in *Hordeum vulgare* (Barley young)' form the second group. *Stereosparmuna snraviolens* (*padal*) leaves with a copper content of 17·8 mg. per kg. stand out characteristically, possessing a value even higher than any of the concentrates. The samples forming the third group include oil cakes, grains and seeds and their by-products. The copper content in these feeds ranged from 9·2 mg. per kg. in *Sesamum indicum* (*til* cake) to 17·2 mg. per kg. in *Cajanus indicus* (*arhar*).

The data presented above serves to throw light on the copper content of various Indian animal feeds and feeding stuffs. Since copper appears to serve as a link in the various physiological processes going on inside the animal body, the adequacy or otherwise of copper in a feed is likely to affect many a vital functions of the animal and is apt to be reflected in the copper content of various animal organs. A study of the copper status of a few more important animal organs was next undertaken.

In Table II figures are given for the copper content of blood, liver, spleen. bone-marrow, lymph-gland and pancreas of six adult normal Kumaoni bullocks. The results have been calculated in mg. of copper per 100 ml. of blood or per kg. of dry tissue.

TABLE II

Copper content of blood and tissues of normal Kumauni bullocks

Kumaoni bullock number	Copper in mg. per 100 ml.	Copper in mg. per kg. on dry weight basis				
	Blood	Liver	Spleen	Bone-marrow	Lymph gland	Pancreas
1	0·148	200·1	16·8	24·6	38·4	22·0
2	0·133	172·9	18·0	27·0	36·0	19·2
3	0·153	160·6	16·2	27·6	39·0	21·0
4	0·129	168·0	15·6	28·8	36·6	23·4
5	0·144	178·6	19·2	25·2	35·4	24·0
6	0·139	164·4	17·4	36·4	37·2	21·6
Average	0·141	173·6	17·2	26·6	37·1	22·0

Of all the tissues examined, liver is the richest and spleen the poorest in copper. In descending order of copper content liver is followed by lymph-gland, bone-marrow pancreas and spleen. The concentration of copper in the liver per unit dry weight is 5 to 10 times the value recorded for the rest of the tissues. The observations regarding the high copper content of the liver are in conformity with those of Bodansky [1921], McHargue [1925] and Tompsett [1935]. The average concentration of copper in the liver of Kumaoni bullocks amounted to 173·6 mg. per kg. on dry basis, which is about six times the concentration of copper in adult human liver [Kleinmann and Klinke, 1930]. The copper content of bone-marrow of Kumaoni bullocks ranged between 24·6 and 28·8 with an average of 26·6 mg. per kg. of the dry tissue. Data on the copper content of bone-marrow are few. Analytical limitations and the difficulty of obtaining satisfactory samples have been a serious handicap. The copper content of spleen, lymph-gland and pancreas on dry weight basis ranged from 15·6 to 19·2, 35·4 to 39·0 and 19·2 to 24·0 mg. with an average of 17·2, 37·1 and 22·0 mg. per kg. respectively. The copper content of the blood of Kumaoni bullocks ranged from 0·129 to 0·153 mg. per 100 ml. with an average of 0·141. The copper content of the blood of different species of normal animals has been studied by [Locke, Main and Rosbash, 1932, Roncato and Bassani 1934 ; Sarata, 1933, Tompsett, 1934]. The values of the copper content of blood quoted by these authors, for the blood of man and most of the animals studied, range between 0·120—0·150 mg. per. 100 ml. The copper content of the blood of Kumaoni bullocks agree closely with these figures.

SUMMARY

The copper content of seventy two common feeds and feeding stuffs and blood and tissues of six normal Kumaoni bullocks was examined.

The copper content of straws ranged from 3·6 to 4·7 mg. per kg. of the dry matter. Oat straw was the poorest. The green feeds representing grasses, leafy fodders and cultivated plants showed a wider range of 5·9 mg. per kg. in *Dichanthium annulatum* (*bara jargi*) to 17·8 mg. per kg. in *Stereosparumuna Snaviolens* (*padal*) leaves. Leafy fooders appear to be a better source of copper compared to straws. The copper content of the concentrates ranged from 9·2 to 17·2 mg. per kg. of the dry sample, the *til* cake being the poorest and *arhar* the richest, in this respect. When arranged in ascending order of copper content, the cereal straws constitute the first group, green feeds the second group and concentrates the third.

Copper content per 100 ml. of blood ranged between 0·129 and 0·153 with an average of 0·141 mg. Copper content of liver per unit dry weight was about 5 to 10 times the value recorded for the rest of the tissues. In descending order of copper content liver is followed by lymph-gland, bone-marrow, pancreas and spleen.

The degree of variation in the copper content of feeds was less than that observed in the tissues and blood of animals.

There is a wide distribution of copper in biological materials, no sample examined being without this element.

REFERENCES

Becker, R. B., W. M. Neal, and A. L. Shealy (1931). Florida *Agric. Exp. Sta. Bull.* No. 231

Bennetts, H. W. and F. E. Chapman (1937). *Austral. Vet. J.* 13, 138

Bertrand, G. (1920). *Bull. Soc. Sci. Hyg. ailment*, 8, 49

Binet, L. and M. V. Strumza (1934). *Sang.* 8, 1041

Black A, O. J. Kahlenberg, J. W. Bratzler and E. B. Forbes (1937). J. *Nutrit*, 14, 521

Bodansky, M. (1921). *J. biol. Chem.*, 48, 361

Boughton, I. B. and W. T. Hardy. (1934). *Texas. Agric. Exp. Sta. Bull.* 499, 32

Bucholz, C. F. (1816). *Report, Pharm.*, 2, 253

Bull, L. B., Marston, H. R. Murnane D. and Lines, E. W. L. (1938). *Commonwealth Austr Council Sci. Indust. Res. Bull.* No. 113, 23

Callan, T. and Henderson J. A. R. (1929). *Analyst,* **54**, 650

Chevruel, M. E. (1868) *Compt. Rend. Acad.* **66**, 567

Dunlop, G. and Wells, H. E. (1938). *Vet. Record.,* **50**, 1175

Eden A. (1950). *J. comp.* Path, 53, 90

Edon, A. and Green H. H. (1940). *Biochem.* J., **34**, 1202

Eenjem, C. A. and Hart, E. B. (1929). *J. biol. Chem.* **84**, 131

Frost, D. V., Potter, V. R. Elvenjem, C. A. and Hart, E. B. (1940). *J. Nutrit,* **19**, 207

Gorter, F. J. (1935). *Nature,* 136, 185

Gooerithault (1929). *Compt. Rend. Acad.,* 171, 196

Hamilton, T. S., Hunt G. E. and Carroll. W. E. (1933). *J. agric. Res.* **47**, 543

Heart, E. B., Steenbock, H. Waddel J. and Elvehjem, C. A. (1928). *J. biol. Chem.,* 77, 797

Kehar, N. D. and Momin, (1950). *Indian J. vet. Sci.*

Keil, H. and Nelson, V. K. (1931). *Proc. Soc. Exp. Biol. Med.* **28**, 392

Keinmann, H. and Klinke J. (1930). *Virchows Arch. Path. Anat,* 275, **422**

Locke, A., E. R. Main and D. O. Rosbash. (1932). *J. Clin. invest.* 11, 527

Mc. Collum, E. V. *et al.* (1939). *Nutrit.* Macmillan & Co.

Mc. Farlane, W. D. (1932). *Biochem. J.* **26**, 1022

Mc. Hargue, J. S. (1927). *Ind. Eng. chem.* **19**, 274

Meissner, W. (1817). *Ann. chem. phys.,* **4**, 106

Myers, V. C., Rem, D. G. and Bing, F. C. (1934). *Abs. Div. Biol. chem. A.C.S. Cleveland,***10**

Oda, S. (1932). *Ztschr, f. d. ges. exp. Med.* 84, 719

Potter, V. R., Elvehjem, C.A. and Hart. E. B. (1938). *J. biol. chem.,* 126, 155

Pullar, E. M., (1940). *Austral. vet. J.,* 16, 147

Roncato, A. and Bassani, B. (1934). *Arch. Sec. Biol.* 19, 541

Sarata, U. (1933). *Japan J. Med. Sci.* II *Biochem,.* 2, 247

Sarzeau, M. (1830). *J. pharm. et. chim.* 16, 505

Schultze, K. W. (1932). *Klin Wehenschr,* 11, 497

Sjollema, B. (1933). *Biochem. ztschr.,* 267, 151

Somogyi, J. (1935). *Mag. Orv. Arch,* **36**, 317

Stein, H. B. and R. C. Lewis (1933)., *J. Nutrit,* 6, 465

Tompsett, S. L. (1934). *Biochem. J.* **28**, 1544

SOME OBSERVATIONS ON THE REGIONAL AND SEASONAL INCIDENCE OF BOVINE CONTAGIOUS PLEURO-PNEUMONIA IN ASSAM*

By V. R. GOPALKRISHNAN, Veterinary Investigation Officer, Assam, Gauhati

(Received for publication on 22 January 1951)

THE existence of the classical contagious bovine pleuropneumonia in Assam as a specific epizootic and its tendency to spread in a slow and insidious manner were recorded in a previous article [Gopalkrishnan, 1943]. A systematic investigation of the occurrence of the disease has been carried out since the month of January 1940 when the writer had, for the first time, an opportunity to observe a natural outbreak of the disease in Goalpara district. Attempts were made to study the nature of the disease in the field in various parts of the Province and to collect all pertinent data. The present paper deals with some observations made on the regional distribution and seasonal incidence of the disease in Assam, for a period of nine years—January 1940 to 1949. During this period, particulars were collected from 43 outbreaks which occurred in 8 districts of the Province. This article also includes similar observations in a locality in Kamrup district, where vaccination trials were undertaken, the results of which were published in an earlier article [Gopalkrishnan, 1946].

Regional distribution

Generally the disease has been known to occur in all the districts of the Brahmaputra Valley, also called Assam Valley. The existence of the disease is usually confined to the contiguous areas lying on either side of the Brahmaputra, from Lakhimpur in the north-east where the river enters the Assam Valley, Sibsagar, Darrang, Nowgong and Kamrup along with its course, to Goalpara on the western border of the Province. Brahmaputra Valley lies on the south of the Himalayan region and numerous tributaries, big and small, flow southwards to join the main river. On the southern sector of the Valley are numerous ranges of hills where from the tributaries flow northward into the river. So the entire valley contains large riverain tracts, swamp forest and marshy lowlying areas with some scattered forest hills. On the bed of the Brahmaputra, which is very wide at some places, there are many islands, known as *charland* or *chars* that are very fertile due to the new alluvium. Apart from the cultivated areas, there are large tracts of grassland with aquatic and other types of grasses. Communications in the interior are not satisfactory and are actually bad in certain localities.

Being a pastoral country, agriculture is the main occupation of the people. Cattle are maintained in fairly large numbers in villages as well as in *khutis*. Maintenance and indigenous breeding of cattle in *khutis* in these parts are rather peculiar.

---

* Paper read at the Indian Science Congress, Section of Medical and Veterinary Sciences, Poona, January 1950.

Khutis are kept mostly by Nepalis and to a less extent by local people, in riverain tracts, forest areas and also in *chars* as there is ample facility for grazing and water supply. Herds of cattle and sometimes buffaloes graze about in areas around the *khutis* and are kept untethered in open enclosures. Milk and milk products are usually produced in *khutis*. Bulls and bullocks are also sold or exchanged. A *khuti* may contain a herd ranging from 25 to 500 animals.

As mentioned earlier, systematic investigation was carried out from the beginning of January 1940 when an outbreak of the disease prevailed in Goalpara district. Materials obtained from this outbreak as well as from others later, were used for experimental work to confirm the existence of the disease in the Assam valley. As outbreaks occurred subsequently, available data were collected to study the epidemiology of the disease. Data obtained from outbreaks in various localities of the Province during a perod of nine years are given in Tables I and II.

TABLE I

Particulars of outbreaks of bovine contagious pleuro-pneumonia in Assam

Serial number	Locality affected		Date of		Number of cattle	
	Village, *khuti* or town	District	Outbreak	Investigation	Attacked	Died
1	Nijalaguri *khuti* (Deosiri)	Goalpara	November 1939	January 1940	46	30
2	Sobanshah	Kamrup	March 1940	June 1940	18	17
3	Patakatchar	Goalpara	June 1940	August 1940	44	29
4	Bordangi forest Reserve	do.	April 1940	September 1940	420	400
5	Barchandra	Kamrup	June 1940	September 1940	80	76
6	Patabari	Goalpara	October 1940	January 1941	140	123
7	Majuli	Sibsagar	March 1941	May 1941	24	15
8	Kokilamori	do.	June 1941	October 1941	55	48
9	Kadamialgaon	Lakhimpur	December 1941	January 1942	20	15
10	Lowly	Kamrup	November 1941	February 1942	75	70
11	Dikhowmukh	Sibsagar	August 1941	March 1942	55	50
12	Tarabari	Darrang	March 1942	May 1942	26	21
13	Kamalabari Satra	Sibsagar	April 1942	June 1942	20	13
14	Tufamari	Goalpara	July 1942	September 1942	35	28
15	Bagarmari	Darrang	October 1942	January 1943	45	45
16	Ahad Busti	Goalpara	December 1942	February 1943	34	30
17	Nakhatra	Nowgong	January 1943	April 1943	30	26
18	Amteka forest area	Goalpara	February 1943	April 1943	62	54
19	Namdeurigaon	Sibsagar	April 1943	June 1943	50	35
20	Chenga	Kamrup	May 1943	July 1943	26	21
21	Barpeta	do.	June 1943	July 1943	3	1
22	Karanga Chapori	Sibsagar	July 1943	July 1943	25	15

TABLE I—*contd.*

Particulars of outbreaks of bovine contagious pleuro-pneumonia in Assam

Serial number.	Locality affected		Date of		Number of cattle	
	Village, *khuti* or town	District	Outbreak	Investigation	Attacked	Died
23	Jorhat	Sibsagar	July 1943	August 1943	11	7
24	Jaobari	Darrang	August 1944	September 1944	35	32
25	Karoligaon	do.	February 1945	March 1945	6	4
26	Naopama	do.	March 1945	March 1945	19	11
27	Marniagury	do.	April 1945	April 1945	13	10
28	Chenga	Kamrup	April 1945	April 1945	17	9
29	Dollijolia	Sibsagar	May 1945	June 1945	24	17
30	Khonoma	Naga Hills	August 1945	October 1945	27	20
31	Dumra	Sylhet	December 1945	March 1946	52	50
32	Shanaboi	do.	December 1945	March 1946	84	80
33	Amteka *khuti*	Goalpara	December 1946	March 1947	25	19
34	Chamaria	Kamrup	April 1947	June 1947	21	16
35	Deosiri *khutis*	Goapara	April 1947	July 1947	40	35
36	Chitoli	Sibsagar	August 1947	November 1947	141	126
37	Kumargaon	do.	September 1947	November 1947		
38	Millenkore	do.	September 1947	November 1947		
39	Samukjan	do.	September 1947	November 1947		
40	Tengaponia	do.	October 1947	January 1948		
41	Dalapa	do.	November 1947	January 1948		
42	Khongia	do.	February 1948	May 1948	29	23
43	Afalagaon	do.	December 1948	January 1949	35	35

TABLE II

Regional distribution of bovine contagious pleuro-pneumonia in Assam for nine years

Serial number	District	1940	1941	1942	1943	1944	1945	1946	1947	1948	Total
1	Goalpara	3	1	1	2	..	..	..	2	..	9
2	Kamrup	2	..	1	2	..	1	..	1	..	7
3	Darrang	..	..	1	1	1	3	..	..	..	6
4	Nowgong	..	..	..	1	..	..	..	..	..	1
5	Sibsagar	..	2	2	3	..	1	..	4	4	16
6	Lakhimpur	..	..	1	..	..	..	..	..	..	1
7	Sylhet	..	..	..	..	..	..	2	..	..	2
8	Naga Hills	..	..	..	..	..	1	..	..	..	1
	Total	5	3	6	9	1	6	2	7	4	43

It will be observed from the above tables that 43 outbreaks occurred in the province and the average mortality rate comes to 86 per cent. Sibsagar district records the maximum number of outbreaks. Generally the disease is noticed in one locality or *khuti* and after some months it spreads to other neighbouring *khutis.* In several cases where such spread of the disease was observed, the unrestricted cattle movement was found to be the cause of the spread. Cattle movement is common for sale in cattle markets or in villages and for exchange of animals between *khutis.* It has also been noted that cattle were sold off, even at a cheaper rate, when the owner observed the onset of disease in his *khuti.* Another factor that contributes to the spread of infection in neighbouring localities is the common grazing ground. Village herds usually come in contact with infected animals during grazing and the disease spreads.

Out of 43 outbreaks that occurred in the province during the period of nine years, 40 were recorded in the Assam valley and the remaining 3 outside it ; one in Naga hills and two in Sylhet district (now in Pakistan). These three outbreaks were found to be due to cattle movement or transportation from plains to the hills during war emergency and immediately after. There was, however, no evidence of spread of the disease elsewhere from these localities after effective control measures were taken. Outbreaks were recorded in the same locality or village twice ; in Deosiri *khutis* in 1940 and 1947, in Chenga village in 1943 and 1945. It appears to be too early to suggest any possibility of cyclic incidence in a particular locality.

Seasonal incidence.—An attempt was made to study whether the conditions of climate are in any way concerned in the prevalence of the disease. The climate of Assam is humid and the rainfall is high, particularly from June to September while it is moderate from March to May. The winter season is short and comparatively dry and summer is shorter still. Due to heavy rainfall and annual floods, large areas of lowlying land are inundated and several tracts remain waterlogged and are generally open for grazing during winter only. Particulars relating to the incidence of the disease and the climatic conditions of the districts [Kanjilal, 1934], are given in Tables III and IV.

TABLE III

Seasonal incidence of bovine contagious pleuro-pneumonia in Assam for nine years

Serial number	Districts	January	February	March	April	May	June	July	August	September	October	November	December	Total
1	Goalpara ..	..	1	..	2	..	1	1	..	..	1	1	2	9
2	Kamrup ..	..	..	1	2	1	2	..	..	..	..	1	..	7
3	Darang ..	..	1	2	1	..	..	..	1	..	1	..	..	6
4	Nowgong	1	..	..	..	..	..	..	..	..	..	..	..	1
5	Sibsagar ..	..	1	1	2	1	1	2	2	3	1	1	1	16
6	Lakhimpur ..	..	..	..	..	..	..	..	..	..	..	..	1	1
7	Sylhet ..	..	..	..	..	..	..	..	..	..	..	..	2	2
8	Naga Hills ..	..	..	..	..	..	..	..	1	..	..	..	..	1
	Total	1	3	4	7	2	4	3	4	3	3	3	6	43

TABLE IV

Climatic conditions of the districts where bovine contagious pleuropneumonia was found prevalent

Name of district	Altitude	Rainfall	Temperature		Average relative humidity
			Maximum	Minimum	
Goalpara	376 ft.	109·05	80·50	66·86	83
Kamrup	712	81·12	83·81	66·36	86
Darrang	560	87·38	83·99	66·56	85
Nowgong	203	68·39	*	*	*
Sibsagar	317	88·19	78·32	66·28	90
Lakhimpur	842	113·17	81·39	65·77	89
Sylhet	290	135·45	86·92	66·00	85
Naga Hills	5692	86·90	*	*	*

* Data not available

The incidence of the disease has been noticed in all the seasons and in all the months of the year ; during April and December larger number of outbreaks were reported while in January, the least. It would appear evident that there is no particular season for its occurrence. The nature of incidence suggests that it is rather erratic or irregular. However, some of the outbreaks were observed about a week or two after heavy rains. It is likely that the chilling due to the rains reduces resistance of the animals so that carriers either break-down or transmit the disease to, in contact with healthy animals. In several places the outbreaks seem to be the reappearance of the disease in an already known infected area or the spread due to movement of cattle. So outbreaks occur generally with no relation to climate, provided there is sufficient reservoir of infection.

DISCUSSION

The occurrence of the disease was observed in all the nine years for which data had been collected. There is, however, some variation in the nature of incidence ; for instance, there was only one outbreak in 1944 and as many as nine in 1943. It would seem that the disease has no periodicity or regularity in its incidence as shown by the figures collected so far.

The reporting of the outbreaks of the disease, was not usually prompt ; there was often much delay, even up to about four to five months. Such delay limits the possibility of taking timely control measures and allows the opportunity for further spread of infection. Although some localities are far in the interior, with bad communications where some delay in reporting is inevitable, there is nevertheless certain improvement and promptness in recent years.

It has generally been reported that in apparently recovered animals, the infective agent remains for a long time in a virulent conditions in necrosed or encapsulated portions of the lung, thus forming sequestra. Such animals remain apparently healthy but sometimes become infectious after some months or even years. No sequestrum formation could be observed on post-mortem examination of several cases of natural deaths in various outbreaks in Assam. However, it seems possible that some recovered animals in an outbreak may retain the infective agent and start further outbreaks or spread of infection at some later date.

In regard to the incidence of the disease in Kamrup district, where vaccination trials were undertaken, no outbreak of the disease was reported for an observed period of five years. The locality chosen was a known enzootic area on the Southern bank of the Brahmaputra. Vaccination was carried out in February 1943 and periodical observations were made for five years. Subsequent to vaccination, no outbreak prevailed in this area, nor did any of the vaccinated animals contract the disease.

SUMMARY

The paper records some observations on the regional distribution and seasonal incidence of bovine contagious pleuro-pneumonia in Assam for a period of nine years—January 1940 to 1949.

In a previous paper on the subject, details were given of the existence of the disease in this country and of the experiments to confirm it in an outbreak in 1940. Since then, systematic investigation was conducted and particulars were collected from 43 outbreaks that occurred in eight districts of Assam.

There is a fairly widespread distribution of the disease in the Brahmaputra Valley of Assam. Outbreaks occur due to unrestricted cattle movement and contact of animals in common grazing ground. Generally, outbreaks seem to prevail with no particular relation to climate as they are observed in all the seasons and even in all the months of the year.

The nature of incidence of the disease in the province in general, and in a vaccinated locality in particular, is discussed.

The work has been carried out under a scheme of research financed by the Indian Council of Agricultural Research, India.

REFERENCES

Gopalakrishnan, V. R. (1943). *Indian J. vet. Sci.* **13, 287**

Gopalakrishnan, V. R. (1946). *Indian J. vet. Sci.* **16, 209**

Kanjilal, U. N. and Coll. (1934). *Flora of Assam,* **1 (1), 30**

FREQUENCY OF OCCURRENCE OF DIFFERENT STRAINS OF FOOT-AND-MOUTH DISEASE VIRUS IN INDIA*

By C. **SEETHARAMAN** and N. S. **DATT**, Indian Veterinary Research Institute, Mukteswar

(Received for publication on 25 June, 1951)

(With one text-figure)

ALTHOUGH foot-and-mouth disease does not cause a heavy mortality among susceptible animals particularly in India, the economic importance of the disease in respect of cattle is so great [Seetharaman, 1950] that scientists have been striving for a long time to evolve a suitable vaccine. The recurrence of the disease in recovered animals after relatively short intervals led various workers to conceive the probability of the existence of different antigenic types of the virus.

Vallee and Carre [Hutyra and Marek, 1922] were the first to distinguish two types of foot-and-mouth disease virus. One was designated ' O ' after the department of Oise where the strain was first examined and the other ' A ' after Ardennes the place of origin. Waldmann and Trautwein later named these types as ' A ' and ' B '. The results obtained by Vallee and Carre were also confirmed by various workers. Subsequently, Waldmann and Trautwein [Hutyra and Marek, 1928] discovered another type of foot-and-mouth disease virus which was designated ' C '. Thus, three different strains of the virus came to be recognised.

With the discovery of the three immunologically different types of the virus, it became necessary for any campaign of vaccination against foot-and-mouth disease to determine the type or types of the virus responsible for spontaneous outbreaks of the disease in a locality. Further, the type determination helps in tracing the source of infection and the mode of its spread. Besides the three standard strains of foot-and-mouth disease virus, there exists in nature a number of other strains of viruses, the antigenic structure of which may show a partial tendency to conform to any one of the three standard types. These are called variants. For instance, a particular strain totally breaks immunity against ' O ' and ' A ' but against Waldmann ' C ' there is a partial breakdown of the immunity, indicating that this particular strain possesses some antigenic relationship with ' C ' strain and hence is referred to as variant of the standard type ' C ' or in short ' C ' variant. The nature of these variants has been explained as due to the characters and the properties of the virus undergoing change during animal passage both in experimental and natural infections. Thus Manninger and Laszalo [1930] demonstrated experimentally that the different variants of the virus were not definite types with fixed properties but only modifications with the immunological characters changed during animal passage. A particular fixed type of the virus may exhibit such a change only in the first few outbreaks after which it may revert to its original fixed types, thereby indicating that the

---

*Work done in the Foot-and-Mouth Disease Research Scheme financed by the Indian Council of Agricultural Research.

variant nature of the strain is only a temporary phase and thus cannot be classified as a fixed type. Again according to Daubney [Hutyra and Marek], we are coming to the stage regarding the virus of foot-and-mouth disease as an extremely liable virus liable to mutations or changes which may completely alter the antigenic properties of any given strain.

METHODS AND MATERIALS

Under a Scheme financed by the Indian Council of Agricultural Research, investigations were started in May 1943 to evolve a suitable vaccine for protecting the Indian cattle against foot-and-mouth disease. To find out first the type or types of the virus responsible for the spontaneous outbreaks of the disease in this country, arrangements were made with the State authorities to collect numbers of field strains of the virus. Tubes containing glycerine phosphate buffer *pH* 7·6 were distributed to the Veterinary Investigation Officers for collecting the virus in the form of unruptured vesicles or scrapings from the lesions of affected animals. The three standard strains obtained from the British foot-and-mouth Research Station, Pirbright, in 1943 have since been maintained in guinea-pigs. The purity of these strains was tested from time to time and they were found to have remained distinct from one another over 62, 69 and 61 passages respectively [Seetharaman, 1949].

Eversince Waldmann and Pape [1920] reported the successful transmission of the disease to guinea-pigs, work on type determination and even quantitative studies on foot-and-mouth disease virus [Henderson, 1949] has been conducted using guinea-pigs because of the ease, convenience and economy with which they can be liberally used. Since these animals do not contract the disease by cohabitation many strains of the virus can be handled in one place without any fear of their getting mixed up. Further, because of the wide prevalence of the disease in cattle, it is difficult to procure clean animals for typing work. It is generally accepted that the type determination carried out using guinea-pigs is as good as with cattle. In all the type determination experiments described in this note, guinea-pigs were used although sometimes it was found necessary to passage the virus received from the field in cattle before it could be successfully transmitted to guinea-pigs. A total of 210 specimens received from the field were examined out of which only 62 proved viable on receipt at Mukteswar.

The materials on receipt were emulsified with phosphate buffer solution *pH* 7·6 and inoculated intradermally in the hind foot pads of guinea-pigs. After 24-96 hours depending upon the virulence of the virus the guinea-pigs developed blisters which also contained lymph. The foot pads were stripped, emulsified as above and inoculated in another set of guinea-pigs. By repeating this process four to six times the field strains were adapted to guinea-pigs. Subsequently, guinea-pigs (immunised against unknown field strains) were tested against Vallee 'A' and 'O' and Waldmann 'C' strains of the virus. By means of the immunological reactions produced in the guinea-pigs the types of the field strains were determined.

OBSERVATIONS

During type determination it was observed that besides the occurrence of the typical 'O', 'A' and 'C' strains, variants of these strains also occurred. There was also an atypical strain which was isolated from natural outbreak of the disease in Rawalpindi [Abdussalam, 1945]. On typing, this strains broke immunity against all the three strandard types, each of which again broke immunity against it.

RESULTS

The results of type determinations (Table I) showed that 37 strains belonged to Vallee ' O ' or ' O ' variant, 17 to Vallee ' A ' or 'A' variant, 7 to Waldmann ' C ' or ' C ' variant and one remained atypical.

TABLE I

Results of type determinations

Type	Number of strains recognized	Province or state of origin	Percentage existence of the strain
Vallee ' O '	20	Baluchistan (1), Gwalior (1), Orissa (1), Punjab (1), Sind (1), United Provinces (15)	32·2
' O ' Variant	17	Assam (1), Bihar (1), Bombay (1), Hyderabad Deccan (1), Kashmir (1), Madras (1), N.W.F.P. (1), Orissa (1), United Provinces (9)	27·4
Vallee' A '	5	United Provinces (5)	8·1
' A ' Variant	12	Central Provinces (1), Madras (2), Punjab (3), United Provinces (6)	19·3
Waldmann ' C '	2	Madras (1), United Provinces (1)	3·2
' C ' Variant	5	Bengal (2), Gwalior (1), Punjab (1), United Provinces (1)	8·1
Atypical	1	Punjab (Rawalpindi) (1)	1·6

DISCUSSION

From the above table it would be observed that all the three known strains occurred in India and the percentage of incidence of the strains were Vallee (O) or ' O ' variant 59·6, Vallee ' A ' or ' A ' variant 27·4, Waldmann ' C ' or ' C ' variant 11·3 and atypical 1·6 (Fig. 1). A reference to the literature indicates that Vallee 'O'

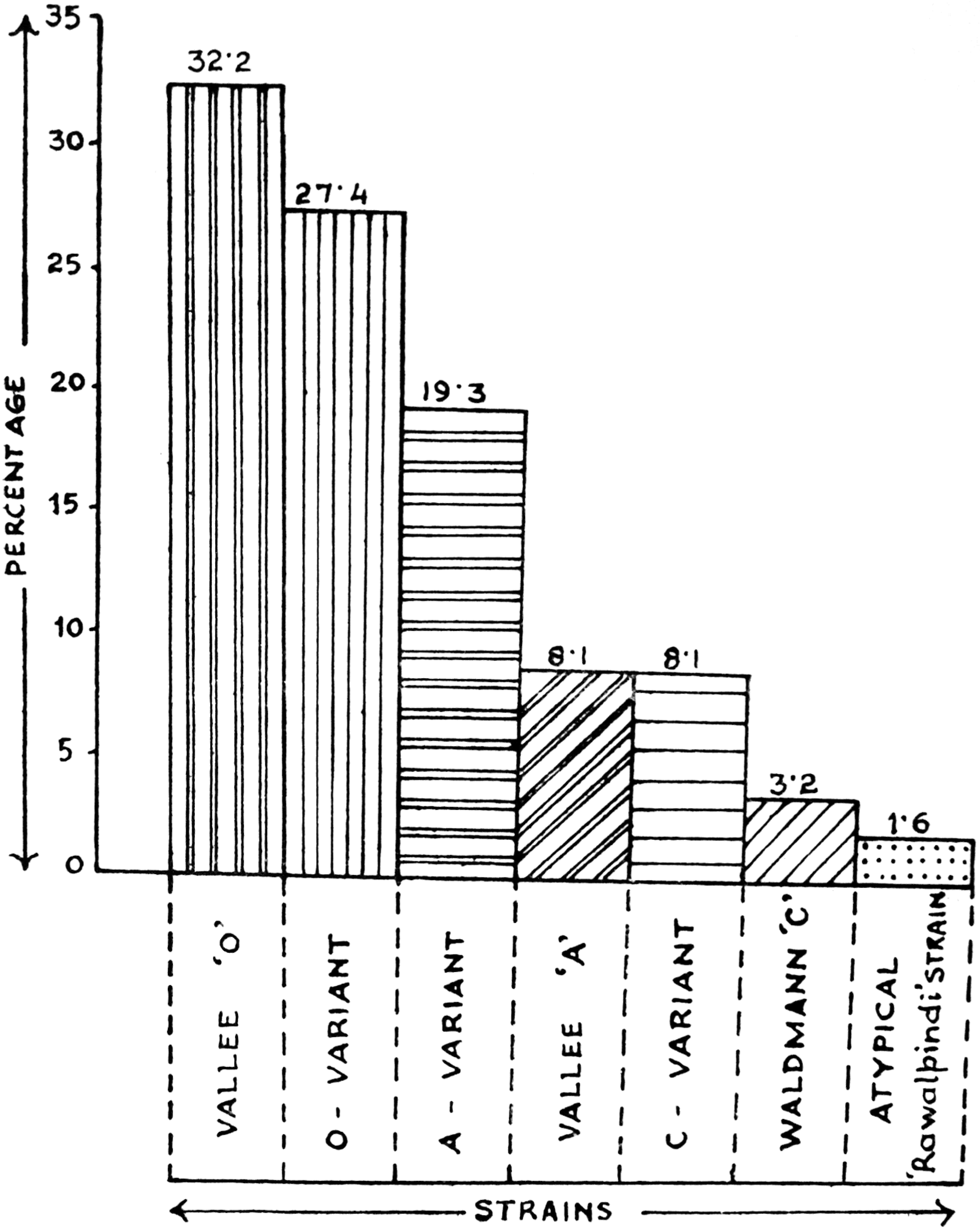

FIG. 1.

predominates, next in turn is 'A' and lastly 'C'. The observations made in India are in agreement with those recorded elsewhere in the world. In the preparation of polyvalent vaccine, the occurrence of the atypical strain could however be ignored because of its rarity.

The atypical strain of the virus isolated is perhaps a variant having some of the characters of any one of the O, A or C, which has been brought about by animal passage during the course of a natural outbreak. There are references in literature to the occurrence of such atypical strains. Manninger [1931] reported that during the period 1927-30, 28 strains were tested in Great Britain of which 27 belonged to 'O' type and one which did not appear to be either 'O' or 'A' or 'C' type. Andrews [1931] described 23 strains isolated in Great Britain from natural outbreaks of which 21 belonged to ' O ' type, the other two not falling under any of the three standard types. These strains were not intermediate but were distinct from one another.

It has been observed under experimental conditions that an animal recovered from an infection of ' O ' and ' A ' is rendered resistant to some extent to an infection with ' C '. This is because Vallee ' O ' and ' A ' occur more frequently in nature, the animals perhaps develop resistance to Waldmann ' C ' and hence the frequency of occurrence of infection with ' C ' is low as compared with ' O ' and ' A '. We are therefore in agreement with Fluckiger [1948] that vaccine containing the two strains ' O ' and ' A ' should be quite adequate for combating foot-and-mouth disease.

SUMMARY

Analysis of the various types of foot-and-mouth disease virus encountered in India is given. Besides incidence of the standard strains ' O ', ' A ' and ' C ' and their variants, the occurrence of one atypical strain was observed. Vallee ' O ' type has been found to be preponderant in India as elsewhere in the world.

ACKNOWLEDGMENT

The authors are greatly indebted to Mr. V. R. Rajagopalan, Officer-in-charge of the Section of Pathology and Bacteriology for his guidance and technical advice.

REFERENCES

Abdussalam, M. (1945). *Annual Progress Report of the Scheme for Vaccination of Cattle against Foot-and-Mouth Disease, Indian Council of Agricultural Research*

Andrews, W. H. (1931). *Fourth Progress Report of the Foot-and-Mouth Disease Research Committee*, London, Section III, 62

Daubney, R. (1934). *J. Comp. Path. 47*, 259

Fifth Progress Report of the Foot-and-Mouth Disease Research Committee, London (1937), 129

Fluckiger (1949). *Vet. J.* 104, 135

Henderson, W. M. (1949). *Report services, No. 8, Agricultural Research Council, London*

Hutyra and Marek (1938). *Special Pathology and Therapeutics of the Diseases of Domestic Animals*, 397

Manninger, R. and Laszalo, S. (1930). *Bull. Int. Epizoot.* 3, 402 (original not seen)

Manninger, R. (1931). *Bull. Int. Epizoot.* 5, 264 (original not seen). *Abst. Vet. Bull.* (1931), 1, 281

Seetharaman, C. (1949). *Annual Progress Report of the Scheme for Vaccination of Cattle against Foot-and-Mouth Disease, Indian Council of Agricultural Research*

Seetharaman, C. (1950). *Indian Fmg.* **11**, 155

Third Progress Report of Foot-and-Mouth Disease Research Committee, London (1928), Section III, 63

Waldmann, O. and Pape, J. (1920). *Berl. Tierar. Wschr.* 36, 519

COMPARISON OF FIRST AND SECOND EJACULATES COLLECTED IN RAPID SUCCESSION FROM THE INDIAN WATER -BUFFALO *BOS BUBALIS*

By S. S. PRABHU and P. BHATTACHARYA, Animal Genetics Section, Indian Veterinary Research Institute, Izatnagar

(Received for publication on 20th May 1951)

INFORMATION on the relative quality of semen samples collected in succession on a given day, or at an interval of days, is of value in intensive utilisation of bulls at artificial insemination centres. It also facilitates drawing up of routine schedules for semen collection from artificial insemination bulls. Considerable data on frequency of copulation and ejaculation and on the relative qualities of ejaculated semen collected in quick succession, or at intervals of days, are available in literature for bulls (Kirillov and Morozov, 1937 ; Davis and Williams, 1939 ; Herman and Swanson, 1941 ; Trimberger and Davies, 1942 ; Anderson, 1941, 1942 a and b ; Webster, 1932 ; Weatherby *et al.*, 1942). No such investigation relating to the Indian water-buffalo *Bos bubalis*, however, has been reported so far. In view of the peculiar position occupied by the Indian water buffalo in the dairy industry* and the growing popularity of artificial insemination as a method of achieving rapid livestock improvement (Bhattacharya and Prabhu, 1950), it became necessary to collect this information. Accordingly the present study was undertaken.

MATERIAL AND METHOD

Over 100 pairs of ejaculates collected in rapid succession at weekly intervals from 8 buffalo bulls Nos. 4, 21, 33, 17, 19, 20, 16, and 31 were analyzed for following semen characteristics :

> (i) *Volume* (ii) *Initial motility* (iii) *Sperm concentration* (iv) *Percentage of abnormal spermatozoa* (v) *Total sperm in an ejaculate* (vi) *Initial pH* (vii) *Percentage of dead sperm* (viii) *Percentage of 'weakly motile' spermatozoa* (ix) *Percentage of 'progressively motile' spermatozoa* (x) *Percentage of 'total motile' spermatozoa* (xi) *Total number of motile sperms in an ejaculate.* In addition, '*reaction time*' was also recorded.

The percentage of dead spermatozoa was determined by using the opal-blue differential staining technique developed by Lasley, Easley and MacKenzie [1942] with the *p*H of the buffer adjusted to 6·6. The percentage of 'weakly', 'progressively' and 'total motile' spermatozoa were found by the technique described by Lasley [1944].

---

*According to the 1945 livestock census about $\frac{1}{3}$ of the total cows and buffaloes kept for breeding or milk production are buffaloes and they are responsible for the production of approximately half the estimated annual milk and milk products.

RESULTS

Averages of the various semen characteristics studied as well as the reaction times for the two ejaculates of the 8 bulls are presented in Table I. The differences between the ejaculates have been tested using the technique of analysis of variance. Due to the obvious correspondence between the first and second ejaculates of different bulls, the analysis given by Snedecor [1947] for two criteria of classification was adopted. The results are shown in Table II. From Tables I and II it will be seen that :—

(i) *Volume.* The average volume of semen in the first ejaculate was uniformly higher than in the second ejaculate. The overall average over bulls for the first ejaculate was 2·33 c.c. as compared to 2·04 c.c. of the second ejaculate. The difference was statistically not significant.

(ii) *Initial motility.* In five out of the eight bulls, the average initial motility was higher in the second ejaculate than in the first. In two bulls (Nos. 33 and 20), it was higher in the first ejaculate, while in one bull (No. 21), it was the same for the two ejaculates. The overall average for the bulls was slightly in favour of the second ejaculate (I=3·07 ; II=3·32). The difference was, however, not statistically significant. Bull X ejaculate interaction, however, was significant at five per cent level showing that between ejaculates differences in initial motility varied significantly from bull to bull.

(iii) *Sperm concentration.* In five bulls (Nos. 4, 21, 33, 17 and 16) the average sperm concentration was higher in the first ejaculate than in the second, while in the remaining three bulls the opposite was the case. The overall average for bulls was in favour of the first ejaculate (1075·92 M/C as compared to 970·79 M/C). The difference was not statistically significant.

(iv) *Percentage of abnormal spermatozoa.* With the exception of Bull No. 4, in all the bulls the average percentage of abnormal spermatozoa was higher in the first eajculate than in the second. The overall average for the bulls was 5·14 per cent for the first ejaculate and 4·16 per cent for the second ejaculate. The difference was statistically significant at 5 per cent level.

(v) *Total sperm in an ejaculate.* The overall average number of sperm in the first ejaculate was 2422·22 millions per c.c. as compared to 1916·88 millions per c.c. in the second ejaculate. The difference just approaches the 5 per cent level of significance.

(vi) *Initial* pH. The average overall *p*H for bulls was slightly higher in the second ejaculate than in the first. The average was 6·79 for the first ejaculate and 6·82 for the second ejaculate. The difference is not statistically significant.

(vii) *Percentage of dead spermatozoa.* In all bulls without exception, the average percentage of dead spermatozoa was decidedly higher in the first than in the second ejaculates. The overall bull average for the first ejaculate was 22·64 per cent as compared to 17·21 per cent for the second ejaculate. The difference was statistically significant at 1 per cent level.

(viii) *Percentage of weakly motile spermatozoa.* With the exception of bull No. 4, the average percentage of weakly motile spermatozoa was higher in the first than in the second ejaculate. The average over bulls for the first ejaculate was 14·66 per cent as compared to 11·61 per cent of the second ; but since between the ejaculates and within-ejaculates variation was high, the difference between ejaculates was found to be not statistically significant.

(ix) *Percentage of progressively motile spermatozoa.* With the exception of bulls Nos. 21 and 33, the average percentage of progressively motile spermatozoa in the second ejaculate was found to be higher than in the first. The average over bulls was 32·62 per cent for the first ejaculate and 41·07 per cent for the second ejaculate. The difference was found to be not statistically significant.

(x) *Percentage of total motile spermatozoa.* In five bulls (Nos. 33, 17, 19, 16 and 31) the average percentage of total motile spermatozoa was higher in the second than in the first ejaculate in bulls, while in the remaining three bulls, it was the other way. The average over bulls was in favour of the second ejaculate by 5·40 per cent. The difference, however, was statistically not significant.

(xi) *Total number of motile spermatozoa in an ejaculate.* In five out of the eight bulls (Nos. 33, 17, 19, 20 and 31), the total number of motile spermatozoa in the second ejaculate was higher than in the first. The average over bulls for the first ejaculate was 480·88 millions and 548·80 millions for the second ejaculate. The difference was not statistically significant.

(xii) *Reaction time.* It was observed that the reaction times varied considerably from bull to bull and within a bull from day to day of collection and within a given day, for the two ejaculates. The average over bulls for the first ejaculate was 33·13 seconds and for the second ejaculate, 38·48 seconds. The difference, however, was not statistically significant.

With the exception of percentage of weakly motile spermatozoa and initial pH, the overall differences between bulls in the various semen characteristic studied were found to be *statistically highly significant.*

CONCLUSION

The two major factors which materially affect bulls in producing uniformly good quality semen and thereby, their intensive use in artificial insemination are (i) volume and (ii) sperm concentration. In *Bos taurus* dairy bulls, Herman and Swanson [1941] observed that the second ejaculate had a larger volume and a higher concentration of spermatozoa. Similar results have also been reported by Anderson [1941, 1942 a, b] and Weatherby [1941]. Our results showed no significant difference either in volume or sperm concentration between the first and second ejaculates of buffalo bulls collected in rapid succession at weekly intervals. The total number of spermatozoa in the ejaculate approached the 5 per cent level of significance and was in favour of the first ejaculate. At the same time, it was observed that the first ejaculate on an average contained significantly larger number of dead and abnormal spermatozoa than the second, which should on an average make the latter ejaculate a better sample for routine use.

SUMMARY

Comparison was made between the various semen characteristics and reaction time of over 100 pairs of ejaculates collected in rapid succession at weekly intervals from 8 buffalo bulls.

With the exception of percentage of abnormal spermatozoa and percentage of dead spermatozoa, differences in no other attributes studied were statistically significant. The difference in total number of sperm in the two ejaculates approached five per cent level of significance. In case of initial motility, the interaction bulls X ejaculates was significant. With the exception of percentage of weakly motile spermatozoa and initial *p*H, variation due to bulls in the other semen characteristics was highly significant.

On the basis of the results obtained, it has been suggested that possibly on an average the second ejaculate obtained at weekly interval may be a better sample for routine use.

ACKNOWLEDGMENTS

The authors are indebted to Messrs. A. R. Roy and V. N. Amble of the Statistical Section, Indian Council of Agricultural Research, for advice in the statistical treatment of the data and to Dr S. Datta, Director, Indian Veterinary Research Insititute, for providing all facilities.

REFERENCES

Anderson, James (1945). Semen of animals and its use for artificial insemination *Imp. Bull. Anim. Gen., Edinburgh*

Bhattacharya, P. and Prabhu, S. S. (1950). Unpublished

Davis, H. P. and Williams, N. K. (1939). *Proc. Amer. Soc. Anim. Prod., 32nd Meet.*, 232

Herman, H. A. and Swanson, E. W. (1941). *Mo. Agric. Expt. Sta. Rec. Bull.*, 326

Kirillov, V. S. and Morozov, V. A. (1937). *A.B.A.*, 7, 120

Lasley, John F. (1944). *J. Anim. Sci.*, 3, 433

——————, Easley, G. T. and Mackenzie, F. F. (1942). *Anat. Rec.*, 32(2)

Snedecor, George W. (1947). *Statistical Methods*. The Collegiate Press, Inc., Iowa

Trimberger, G. W. and Davies, H. P. (1942). *J. Dairy Sci.*, **25**, 692

Weatherby, E. T., Reece, R. P. and Bartlett, J. W. (1942). *J. Anim. Sci.*, **1**, 80-81

Webster, W. M. (1932). *Aust. Vet. J.*, **8**, 199

ABSTRACTS

The Low Temperature Storage of Ram, Bull and Rabbit Spermatozoa. EMMENS, C. W. and BLACKSHAW, A. W. (1950). *Aust. vet. J.* **26**, *No. 9, 266-268*

THE paper gives the preliminary account of the results of preserving mammalians spermatozoa at low temperature.

A percentage of human spermatozoa survive rapid freezing to —79° C. in their own seminal plasma and in that of ram, bull and rabbit, but spermatozoa of other species fell to stand similar treatment. A series of tests were repeated with 24 samples of ram semen, each in several replications. Ram spermatozoa were slowly frozen to —79° C. in mixtures of glycerol and a pentose. The best results were obtained with 7·5 per cent to 10 per cent of glycerol and 1·25 per cent of arabinose, rhamnose and xylose in the semen diluent mixture. The results also indicated that revival of spermatozoa would have been complete at temperature not below —25°C. This, however, needs further confirmation. The same method with bull semen gave equally good results in a run of 12 tests. There was no diminution of activity of spermatozoa after three or four days of storage at —79°C., thereby showing that semen could be preserved in that state for a long time.

The diluents used in ram and bull semen are more toxic to rabbit spermatozoa than bull or ram spermatozoa. Rabbit semen slowly frozen to —79°C. in 7·5 per cent of ethylene glycerol with 1·25 per cent or more of various sugars showed revival of spermatozoa upto 25—30 per cent. Further work is being continued to evolve a less toxic diluent (G. S.)

Some Factors Confirmed with Practical Aspects of Progency Testing. HUTT, E. B. (1950). *B. vet. J.* **107**, *No. 3, 97-103*

AS the result of 15 years of poultry breeding with the object of evolving a Leucosis resistant, higher and larger egg producing, early maturing and good body sized strain, the author has concluded the importance of various factors that make progency testing easier and more profitable.

An important one was to reduce the testing period to 500 days after hatching, instead of the traditional 365 days after first egg, to get the results quicker and thereby economise on utilisation of the housing space, allowing more time for computation of records and encourage early maturity. The records were kept on a separate card for each pullet, dam, sire, etc. and a master sheet for comparison of all sires. Annual record cards of pullets were punched and slotted to permit quick calculation and evaluation of results. Partial tests for four months were also carried as they permitted immediate reuse of the best sires and dams and allowed an extra year of reproduction from them. Cockrels were picked up by sib tests i.e. by the performance of their full and half sisters. Egg size was measured by taking an average of the weight of four eggs from each first year pullet during March and December instead of throughout the year. To get a maximum number of proven sires, 'multiple shifts' of cockerels were used on a definite number of pens, each having at least 18 females, so that each male got about 50 *daughters.* Artificial insemination was also practised to shorten the interval between successive males when paternity was uncertain. (B. N. G.)

A Note on Newcastle Disease. Zaki Morcos (1950). *B. Vet. J.*, **106**, *240-241*

THE author, as a result of his experiments and experience claims, that Ranikhet Vaccine, with an average dose of 1 c.c. of a 1/1000th suspension of dried chick embryo attenuated culture as an effective prophylactic, has a curative effect of saving about 50 per cent of the affected birds irrespective of their age, when given in small repeated doses, whereas 100 per cent of the unvaccinated birds die (trials will be worthwhile in India). (B.N.G.)

Control and Prevention of Neurolymphomatosis (Fowl Paralysis). Wilson, J. E., (1950). *B. Vet. J.* **106**, *196-200*

IT is observed, that young birds are most susceptible for fowl paralysis during the first 4 weeks of their life, and therefore strict isolation by removing them from contaminated runs or where, this is not possible recourse to intensive system, is suggested as measure of prevention. All direct or indirect contact with adult birds during the critical period i.e. the first six to eight weeks after hatching should be avoided, because of the danger of their being carriers, inspite of apparently being healthy. An experiment on above lines showed 1·11 per cent mortality in stock reared on uncontaminated grounds as compared to 34·4 per cent mortality in chicks reared on contaminated one. In another experiment, where isolation was effected after eight weeks, age, there was no material reduction in disease incidence.

The author finds that direct egg transmission of the virus is not so important a factor in causing serious losses, as the *non-isolation* during the first few weeks of life. Routine fumigation, soon after setting eggs, will eliminate the virus from egg shells contaminated through birds, droppings.

Large scale production of high degree resistant males from State aided breeding stations for distribution to the poultry industry is suggested. (B.N.G.).

Some Aspects of Immunity in Rinderpest. Mukerjii, A. (1951). *Indian Vet. J.*, **XXVII,** *No. 5, 351-355*

THE article is a review of the work done in the evolution of an effective rinderpest vaccine in the country, which materialised in 1928 with inactivation of rinderpest virus after being passaged through the goat and being fixed at the eightieth passage. It is mentioned that antigenicity of G. T. V. varies with the nature of the strain, the type of goat, the number of passages, the age and condition of vaccinated animal, the post-vaccination treatment and the climatic conditions prevailing at the time.

The type of reaction has no relation to the degree of immunity. The field strains also vary in their virulence, which points out towards multiplicity of rinderpest virus strains and for the same reason the antigenic value of the G. T. V. produced in the State may vary.

The period of immunity in hill cattle is mentioned as 10 years and 3 to 5 years in the Plain cattle. Degree and duration of immunity can be increased, by keeping the vaccinated animals away from the heating effects of the sun, i.e. by vaccinating them in winter ; and by giving protein rich food to stimulate the antibody formation in the body. The author prefers the subcutaneous system of inoculation to scarification method, because of the severity of reaction obtained in the latter and because of its being more or less an intra-glandular injection, on account of the intimate connection between the skin and lymphatics. Immunity is likely to be stepped up and prolonged if animal is given a suitable sensitizing dose 6 days prior to immunising dose. (H.K.I.).

Protein as an Indicator of Pasture Forage Digestibility. R. M. Forbes (1950). *J. Anim Sci.* **9**, *231*

IN the present article an attempt has been made to evolve method of calculating the dry matter digestibility of forage from the protein content and the predicted protein digestibility. Data from digestion trials with steers and sheep were used for the purpose of these calculations. The digestibilities calculated by the protein digestibility method were compared with similar data obtained by conventional and lignin ratio methods. It was observed that the protein digestibility method gave average results similar to those obtained by the other two methods, generally. However, the slope of the regression lines relating dry matter digestibility to lignin content of the forage was less when the protein digestibility method was used than when either of the other two methods was used. The difference in slopes is, however, statistically significant in case of lamb trials only. A consideration of the data indicates that although the calculation of dry matter digestibility from predicted protein digestibility fails to attain the expected accuracy in all cases, the method may be used with a satisfactory degree of accuracy in case of grazing steers. (B.S.)

Bovine Mastitis. A Comparison of the Value of Diagnostic Methods. Chu, S. J. (1949). *J. Comp. Path Therap.*, **59**, *81-90*

A STUDY of 87 quarters from 26 cows affected with mastitis was made with a view to correlate the results given by five indirect tests and the culture test of milk samples with those given by the cultural and histopathological examination of the udder tissue from which the milk was collected.

The accuracy of the indirect tests e.g. chloride test, catalase test, whiteside test, bromothymol blue test and the total cell count, when judged on the basis of culture test was 50·6, 46·0, 49·4, 55·2 and 45·0 per cent respectively, each test showing a high percentage of false positives. When assessed upon histopathological examination of the udder it was 87, 92, 82, 43·6 and 100 per cent respectively. The accuracy of the culture test by a similar comparison with the histopathological examination was only 45 per cent thereby showing that the culture test did not reveal all cases of mastitis and those cases in which the pathogenic organism was absent but inflammation was present would be classified as false positive, thus reflecting erroneously upon the value of indirect tests.

A total cell count of 100,000 per ml. generally regarded as the border line for normal milk was shown to be too high and a count above 21,000 per ml. was regarded positive for mastitis.

The pathological changes caused by *Str. agalactiae* were found to be primarily subacute catarrhal, marked by highly productive changes in the interstitial tissue and sever leucocytic infiltration in the alveoli, while those caused by *Str. dysgalactiae*, *Str. uberis* and pathogenic staphylococci were much milder. In one case of *Corynebacterium pyogenes* infection the lesions were mainly severe, subacute and were characterised by the presence of a suppurative exudate. The fibrous tissue was formed, which persisted resulting in extensive fibrosis. (M.M.S.).

Storage of Bull Spermatozoa at low Temperatures. AUDREY, U. S. and POLGE, C. (1950). *Vet. Rec.* **62**, *115-116*

THE paper deals with the effect of glycerol on the revival of bull and goat spermatozoa from very low temperatures without considering the fertilising power. Samples of diluted bull and goat semen having concentrations of 5, 10, 15 and 20 per cent glycerol showed full motility, both immediately after and 3 hours after dilution when kept at room temperature (+20° C.) or at +2°C. Motility was higher after 24 hours at +2°C. than at +20°C. Sample of semen diluted in egg-yolk citrate showed no better result at these temperatures.

Samples cooled at the rate of 1°C. per minute from 0°C. to —79°C. showed 50 to 60 per cent revival in 5 per cent glycerol and about 70 per cent revival in 10 per cent and 15 per cent glycerol. Another set of tubes cooled in eleven successive stages at 0°C., —2°C., —5°C., —8°C., —10°C., —13°C., —15°C., —26°C., —40°C., —60°C. and —79°C. with $2\frac{1}{2}+5$ minutes at each temperature, showed similar results; but the order of 90 per cent revival was found in 15 per cent glycerol on three additional stages of —30°C., —50°C. and —70°C. When sealed ampules of bull semen in 15 per cent glycerol were thus cooled and then thawed after 10 minutes, 2 hours and 24 hours at —79°C., sperm motility was undiminished. In samples stored at +2°C. or at +20°C., after thawing, motility was slightly reduced after 3 hours but diminished considerably after 24 hours. (K.D.B.).

The Cattle Trypanosomiases Cryptic Trypanosomiasis. FIENNES, R. N. T. W. (1950). *Ann. Trop. Med. Parasit.* **44**, *222-237*

IT has long been recognised that *Trypanosoma vivax* in cattle become 'cryptic' or create a state of 'premunition'. The author after reviewing the literature on the subject has dealt in detail with:

(1) the course of *Trypanosoma congolense* infection in cattle; (2) the demonstration of antibody as a proof of the existence of secondary trypanosomiasis; (3) blood changes occurring during the incubation period of acute *T. vivax* infection of cattle; (4) the cryptic infection resulting from subcurative therapy and (5) the cryptic infection following the prophylactic use of drugs. The author reported in an earlier study that *T. congolense* hitherto considered to be a blood parasite, has also been found to act as a tissue parasite in the adrenal cortex and in the anterior pituitory glands. Though such findings were not constant but it was suggested by him that the lesions in the endocrines might have been caused by the direct action of the flagellates in the tissues.

In discussing the results obtained from his observations on the above lines he emphasized that the cryptic infection of cattle trypanosomiasis constituted a form of 'secondary trypanosomiasis'. This condition was consequent upon a natural 'primary' stage, and that it was disease entity which could produce morbid symptoms ultimately resulting in the death of the animal.

The author suggests that it was probable that the cryptic parasites in the animal body were active and not lying dormant, and that there was some focus of infection, but, where it was located and in what way it produced pathologic condition yet remained to be discovered. The reasonable hypothesis that followed was that during the secondary stage of trypanosomiasis the antibody in the serum was powerful enough to prevent blood invasion unless of course the host was subjected to some adverse conditions. The author suggests that the small number of trypanosomes that may have appeared in the blood from time to time was perhaps, due to an overspill from some tissue focus rather than the active cause of symptoms of disease. It was also reasonable to suppose that if substances inimical to trypanosomes were present in the blood serum they would inhibit the primary blood invasion and resulted in the creation of a tissue focus which might or might not be accompanied by active symptoms. This explained how the drug prophylaxis and unsuccessful drug therapy led to inhibit the primary stage of the disease but allowed the development of the secondary stage. The antibody could be demonstrated in the serum during both primary and secondary stage but disappeared when the parasites were eliminated. It has been emphasized that the demonstration of antibody was a sure test of the presence of cryptic infection.

The author has rightly concluded that the problem of trypanosomiasis could only be solved by a thorough study of the pathology and immunity reactions of the host and the behaviour of the parasite in response to exposure to sera and drugs. (H.N.R.).

REVIEWS

INDEX OF TREATMENT

BY HAMILTON KIRK

(*Published by Bailliere Tindall and Cox—London—1951, pp. X+***826**, *40 S.*)

THE book is divided into three parts. Part I deals with different kind of therapy, antiseptics and anaesthetics. Separate chapters are assigned to the therapy by Actino, Electro, Chemo, Hormone, Vaccine and Serum, Vitamin, and therapy by the Barbiturates. This part gives the reader all the up to date and modern knowledge on the therapy by all such known methods and the most suitable methods of practising efficient antisepsis and anaesthesia, in so far as the small animals are concerned.

Part II then deals with the index of treatment proper. This is a sort of encyclopaedia covering all affections met with, in small animal practice that require medical or surgical intervention : In a brief and concise manner is mentioned the steps necessary to be taken to deal with all the ailments.

Part III has chapters devoted to imparting knowledge on such essential items as handling and restraint of small animals, administration of medicines, care and feeding of sick, humane methods of euthanasia. The posological table is at the end of this part.

The subject matter in the book is neatly described and well illustrated. Throughout the book is written in a clear and simple style. The printing and get-up are commendable.

The book is invaluable for all veterinary practitioners in this country, particularly in urban areas where small animal patients are by no means infrequent. The book should also prove of great help to veterinary students who require knowledge concentrated in a nutshell. (M.R.M.).

BREEDING AND IMPROVEMENT OF FARM ANIMALS*

BY VICTOR ARTHUR RICE

(*Published by Mc/Graw-Hill Book Co., New York, 1942, 3rd ed., 10th imp. pp. X+750, 213 fig, Price Rs. 5·50*)

THE book is an excellent general treatise on the subject, both for students and practical breeders. It presents the principles of animal breeding and related sciences and their application in farm animal breeding practice. The essentials of animal breeding have been dealt with in accurate yet simple style, and the book is extremely lucid reading. There are four sections.

---

*With chapters on the endocrine basis of reproduction and artificial insemination by Dr Frederick Newcomb Andrews.

Section I gives the historical background of the present day animal breeding industry in three chapters, and traces back to the domestication of animals, early man and the origin and evolution of animals.

Section II deals with the problems of multiplication in eight chapters. The various aspects including the roles of the male and female, the endocrine glands, the artificial insemination in fertility, and the physiology of reproduction and lactation, are discussed.

Section III is about the variations in different characters. In eight chapters it discusses the mechanism and modes of their inheritance. Inclusion of a chapter on the statistical analysis of variation makes the determination and explanation of its genetic basis complete.

Section IV explains the artifices in the art of successful breeding of improved stock. Breeding systems have been classified on basis of relationship and the points in selection for various purposes and kinds of livestock are brought out. The seven chapters are rounded off with one on food for thought for those who aspire to contribute their mite in increasing the exploitation of the profit making machinery that man has made of animals.

There is a list of references for each chapter, and also an appendix on inheritance studies in animals and a general index at the end. A list of the livestock record associations makes another useful appendix and provides a channel of contact with the livestock development in progress in the U.S.A. The book is profusely illustrated. Except for chapters 13, 14 and 15, one, however, misses the chapterwise questions and problems which form the life of teaching and learning in many excellent text books. Perhaps a list of top-notch herds of different breeds of livestock would have also been a useful inclusion. And then a chapter on profitable disposal of good animals to keep up the incentive for producing improved stock would have been very welcome.

Doubtless, the book has been extremely useful and popular as it is, since, during the last decade or so, its 3rd edition has gone into ten impressions.

No one interested in animal breeding science, be he a teacher, a student or a practical breeder, can afford to do without a copy of this book. (P.B.).

MGIPC—M—26 AR—19-7-52—850.

Effective as D D T.

RHOTHANE (dichloro diphenyl dichloroethane), also known as D D D or T D E, controls HORN FLIES, LICE and TICKS. RHOTHANE has been extensively tested and used commercially under actual range conditions. RHOTHANE sprays are as effective as D D T in the control of HORN FLIES, LICE and TICKS.

Safety important.

The problem of toxicity of D D T and other insecticides is causing increasing concern among cattle owners. At the same time, it is well established that RHOTHANE is many times safer than D D T to MAN and LIVESTOCK.

The effectiveness of RHOTHANE sprays in combating parasitic insects of livestock plus its wide margin of safety to warm blooded animals makes RHOTHANE a logical insecticide for this purpose.

Directions for use.

Use either RHOTHANE WP 50 or 25% RHOTHANE Emulsion Concentrate.

8 lbs of RHOTHANE WP 50 in 100 gallons of water

or

2 gallons of RHOTHANE Emulsion Concentrate in 100 gallons of water. Use 1 to 4 quarts per head in fly season; 2 to 4 quarts for lice.

P. 274/1/52.

Publications Committee

Sardar Datar Singh, F.R.S.A., *Vice-President, Indian Council of Agricultural Research*

K. R. Damie, I.C.S., *Joint Vice-President, Indian Council of Agricultural Research*

R. L. Sethi, I.A.S., *Agricultural Commissioner with the Government of India*

P. N. Nanda, M.R.C.V.S., *Animal Husbandry Commissioner with the Government of India*

B. P. Pal, M.Sc., Ph.D., F.L.S., *Director, Indian Agricultural Research Institute*

S. Datta, D.Sc., M.R.C.V.S., D.T.V.M., F.R.S. (Edin), F.N.A., *Director, Indian Veterinary Research Institute, Mukteswar*

K. C. Sen, D.Sc., *Director, Indian Dairy Research Institute, Bangalore*

S. B. Singh, M.Sc., Ph.D. (Cambridge), *Director of Agriculture, Uttar Pradesh*

H. B. Shahi, M.Sc., M.R.C.V.S., *Animal Husbandry Commissioner to the Government of Uttar Pradesh, Lucknow*

A. R. Vyas, *Director of Publicity, Ministry of Food and Agriculture (Agriculture), New Delhi*

Hem Singh Pruthi, M. Sc., Ph. D., Sc.D. (Cantab), F.R.A.S.B., F.N.I., *Plant Protection Adviser to the Government of India*

P. Parija, D.Sc., *Pro-vice Chancellor, Banares Hindu University, Banares*

J. V. A. Nehemiah, I.A.S., *Secretary, Indian Council of Agricultural Research*

U. N. Chatterjee, D. Phil., F.N.A.Sc., *Editor, Indian Council of Agricultural Research*

The Editorial Board, in its work of examining papers received for publication, is assisted in an honorary capacity by a large number of scientists working in various parts of India.

Publication communications including books and periodicals for review should be addressed to the Secretary, Indian Council of Agricultural Research, Publication Section, New Delhi.

Communications regarding subscription and advertisements should be addressed to the Manager of Publications, Civil Lines, Delhi.

INSTRUCTIONS TO AUTHORS

Articles intended for *The Indian Journal of Verterinary Science and Animal Husbandry* should be accompanied by short popular abstracts of about 300 words each.

In the case of Botanical and Zoological names the International Rules of Botanical Nomenclature and the International Rules of Zoological Nomenclature should be followed.

References to literature, arranged alphabetically according to authors' names, should be placed at the end of the articles, the various references to each author being arranged chronologically. Each reference should contain the name of the author (with initials), the year of publication, title of the article, the abbreviated title of the publication volume, and page. In the text, the reference should be indicated by the author's name, followed by the year of publication enclosed in brackets when the author's name occurs in the text, the year of publication only need be given in brackets. If the reference is made to several articles published by one author in a single year, these should be numbered in sequence and the number quoted after year both in the text and in the collected references.

If a paper has not been seen in original it is safe to state ' original not seen '. Sources of information should be specifically acknowledged.

As the *format* of the journal has been standardized, the size adopted being crown quarto (about $7\frac{1}{8}$ in.× $9\frac{5}{8}$ in. cut), no text-figure, when printed should exceed $4\frac{1}{2}$ in. ×5 in. Figures for plates should be so planned as to fill a crown quarto plate, the maximum space available for figures being $5\frac{3}{4}$ in.×8 in. exclusive of that for letter press printing.

Copies of detailed instructions can be had from the Secretary, Indian Council of Agricultural Research, New Delhi.

EDITORIAL BOARD

P. N. Nanda, M.R.C.V.S., *Animal Husbandry Commissioner with the Government of India*

S. Datta, D.Sc., M.R.C.V.S., D.T.V.M., F.R.S. (Edin), F.N.I., *Director, Indian Veterinary Research Institute, Mukteshwar*

K. C. Sen, D.Sc., *Director, Indian Dairy Research Institute, Bangalore*

James N. Warner, M.Sc., *Head of the Department of Animal Husbandry and Dairying, Allahabad Agricultural Institute, Allahabad*

Editor

U. N. Chatterjee, D. Phil., D.Sc., F.N.A.Sc.